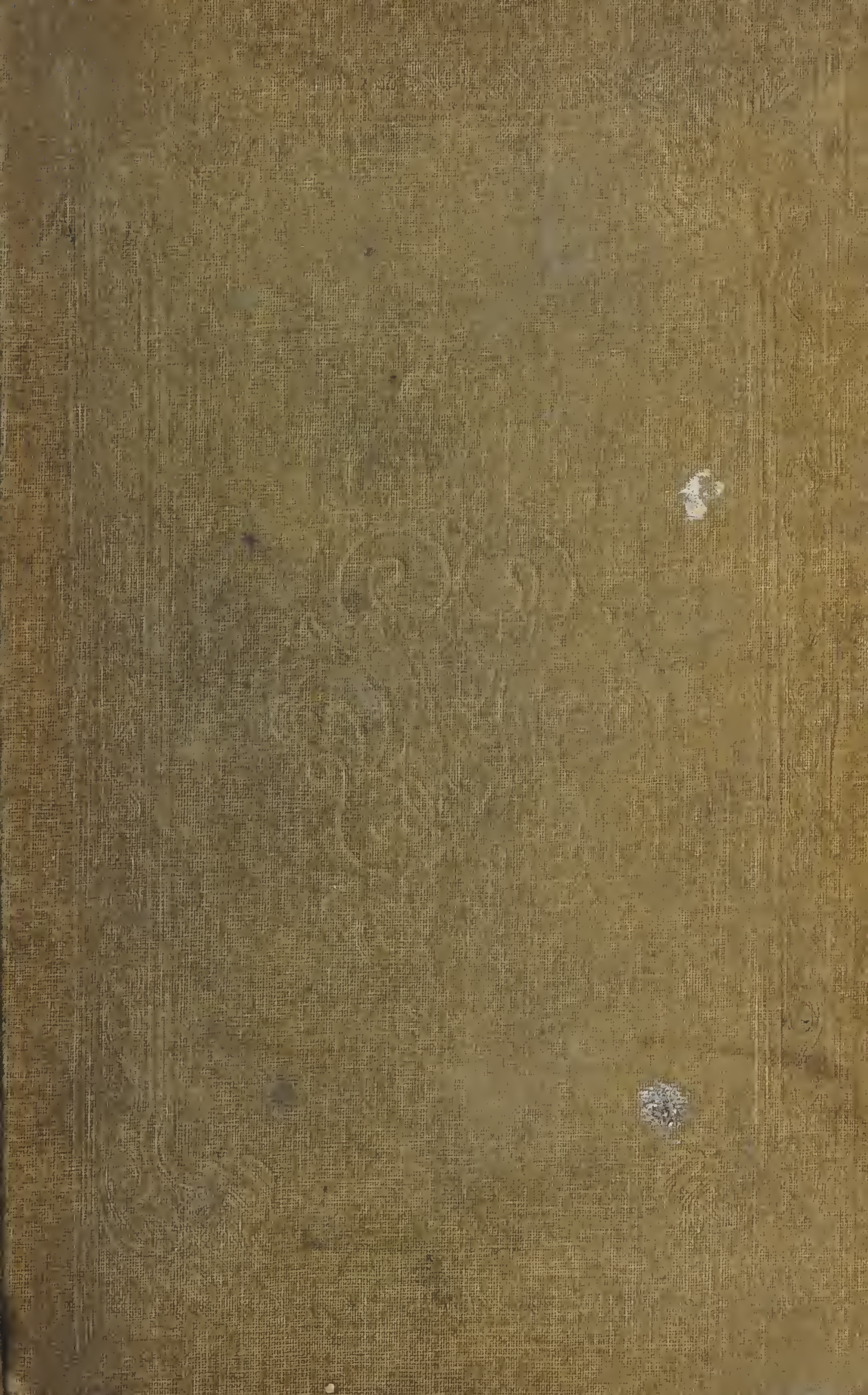

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GEOLOGY.

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Patck e Elligott

He spoke and they were made:
He commanded and they were created.

PSALM 148.

GEOLOGY

IN ITS RELATION TO

Revealed Religion.

BY C. B.

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PREFACE.

THE following work is not intended as a regular treatise on Geology, nor does it add new discoveries to those already made in this infant science: its objects are, however, important. It distinguishes useful and interesting knowledge, from idle and absurd speculations; divests scientific truths of every semblance of fable and romance; substitutes arguments founded on reason and religion, for theories based upon vague and insufficient data; and elevates to its legitimate position among modern branches of popular knowledge, a science hitherto of no good repute, on account of the irreligious purposes to which it has been perverted.

In these pages, the erroneous opinions of geologists are refuted, without impugning the rational inferences drawn from geological facts; the line of demarcation is carefully traced between just, legitimate deductions, and opinions founded on mere possibilities; discrepant theories are so contrasted as to make it appear that no one of them possesses those characters by which any system, having truth or consistency for its basis, can be recognised; and every effort is made to disarm that hostility which, with much apparent justice, has generally existed against this useful and interesting branch of knowledge.

Geology has, for several years, engaged the attention of the learned, and numerous theories have been devised to explain its phenomena. Systems have been framed to accord with the preconceived notions of philosophers; every fossil is made the subject of some new hypothesis; and all this to establish the "immeasurable age of our planet," and the countless lapse of ages through which animals and vegetables are supposed to have existed. It may be well to observe here, that no argument in favour of the indefinite age of the earth can be deduced from the distance of the fixed stars, and the progressive motion of light, as the distinct light of the sun, and each of the fixed stars, was cast to its utmost limit, the very instant they were called into existence. The radiation of light from centres is necessary to produce those beautiful diversities of light and shade which adorn the universe; but, as God saw that all the works he made were good, he saw, too, that they were perfect. Light moves progressively from those luminous bodies to which it is attached, but it moves and radiates only in the track which the first rays that emanated from the hand of the Creator, had marked out to those that were to follow.

The most remarkable of the theories alluded to, relate to the change of the earth, from its original nebulous or fluid state, to its present condition; and to the production of the various orders of rocks. "Geology teaches," says Dr. Hitchcock, "that the time has been when the earth existed as a molten mass of matter. I should be sustained by many probabilities if I were to go further, and maintain that the time was when the globe existed in a gaseous state." Phillips, alluding to the theory of rock-formation, says, "the matter of metamorphic rocks, derived from rocks of the granitic kind, and suspended in vast oceans, was, when deposited, subjected to a great heat from below, which gave it, in its reconsolidation, much of that crystalline texture which it had in its plutonic form."

It is too evident, how these and similar notions tend to the subversion of Scripture. Were the earth a fragment of the sun, struck off from that luminary by the impact of a comet, as Whiston imagined; or did it owe its origin to the accumulation of nebulous matter, it would be useless to assert that no fiery nucleus existed within it, or that no classes of rocks owed their origin to a central heat. If chalk, and limestone, and silica, are animal productions, as some geologists affirm; if coal owes its origin to the vegetable world; and if existing continents have been formed of the worn-down materials of by-gone worlds, it would be useless to argue in favour of the literal meaning of Scripture, or to assert that sufficient time for the accomplishment of such mighty works elapsed within the historic period. And could it be shown that extinct plants and animals had no connexion with existing races, it would be to little purpose to cite Scripture against the doctrine of successive creations of organic beings. These geologists may justly be classed among those of whom Balmez speaks thus: "There is a universal and constant fact in the history of the human mind—viz., its decided inclination to invent systems in which the reality of things is completely laid aside, and where we only see the workings of a spirit which has chosen to quit the ordinary path, in order to give itself up to its own inspirations. The history of philosophy is a perpetual repetition of this phenomenon, which the human mind shows, in some shape or other, in all things which admit of it. When the mind has conceived a peculiar idea, it regards it with that blind and exclusive predilection which is found in the love of the father for his children. Under the influence of this prejudice, the mind develops its ideas, and accommodates facts to suit it; that which at first was only an ingenious and extravagant idea, becomes the germ of important doctrines; and if it arise in a person of an ardent disposition, fanaticism, the cause of so much madness, is the consequence."

The rash opinions of geologists, which have made the science a term of reproach in the world of reason and religion, are too numerous to be noticed in this preface, but are stated at full length in the following pages. The existence of a central-heated nucleus is disproved; coal, chalk, limestone, &c., are shown to be true minerals; extinct plants and animals, proved to have been portions of the existing systems, and the precise forms wanted to fill up the hiatus in the present races; and the species which now inhabit the earth, are shown, generally, to have been created with powers capable of enduring all those changes of circumstances which could result from alterations in the physical geography of the earth.

Every one friendly to a science of paramount importance to the mining and agricultural pursuits, and to almost every other department of national industry, should labour to allay that hostility which has long existed against geology. The advantages accruing to society from the several discoveries made in this science, should not be relinquished because infidels have attempted to make it subserve their own anti-Christian and impious purposes. The facts of geology should not be condemned because of the many extravagant theories to which they have given rise. The instrument should not be doomed along with the hand which directs its operations.

Several well-meaning geologists have been led into error by the analogical mode of reasoning. "If," say they, "the earth be now in a state of refrigeration, it must have formerly been much hotter;" and this mode of argument being plausible, the transition was easy to that of the fusile, or gaseous state of the whole globe. From the degrading and elevating causes now in active operation through every part of the globe, geologists infer the existing lands to be but "one item in the series of worlds which have passed away, and are to succeed the present continents." By similar reasoning on organic fossils, they conclude, that "distinct races of plants and animals, occupied this earth for indefinite ages, anterior to the creation of man; that successive geological eras are marked by forms of life quite distinct from any that followed, or had preceded them; and that whole families of organic beings naturally die away, and are succeeded by new races, which are constantly being introduced on earth."

Those who advocate the eternity of matter, may, with some show of consistency, use this mode of argument; but such as believe in the Scripture narrative, and in one great miraculous, omnipotent act of creation, have no such palliative for their erroneous opinions. To reason from analogy, we must always compare parallel cases. We may say that Newton acquired his science, as Demosthenes did his eloquence, by long study and intense application; but we cannot say that Solomon's wisdom was so acquired, though such would be our conclusion were we ignorant of the source whence it proceeded. If we trace the existence of plants or animals through a series of generations, we are justified in deducing analogical conclusions, but not so when the first plants and animals, as they came from the hands of the Creator, are the subject of our consideration. In them, we would, too, discover every trace of a former existence which they never enjoyed; every mark of a previous infancy through which they never passed. Here our analogy, though true in appearance, would be false in effect. Our reasoning holds good as long as the cases are analogous, but fails altogether as soon as we judge of created beings by those produced in the ordinary mode of generation.

The same is true as regards the whole earth; we could apply those laws by which its physical changes are now marked, to its state, when the work of the six days was accomplished; and yet, how void of truth would be the inference! As we know nothing of the earth when new, and as it came from the hands of the Creator, we have every reason to believe it was perfect in all its parts, with as many indications of a long-anterior existence, as the most acute disciple of Cuvier would discern in the

> "Numerous living creatures, perfect forms—
> Limb'd and full grown," . . . .

which sprang into life when God said, "Let the earth bring forth the living creature in its kind, cattle and creeping things, and beasts of the earth," &c. And as we could discover in the first lion or elephant every lineament, every discriminating feature, which marks all the kind, so we could perceive in the earth's crust, while yet new, stratified and unstratified rocks, sandstones and limestones, chalk and silica, coal, culm, and all the various substances which now supply matter for all the theories of geology. It is, then, unfair to deduce arguments subversive of Scripture, from assumed analogy, in cases where no analogy exists.

Even just arguments, drawn from analogy, are not always favourable to geological theories. Every naturalist now admits the reticulated nature of the existing animal and vegetable kingdoms. If there existed formerly a multitude of distinct races of plants and animals, every such distinct creation (reasoning by analogy) should have formed a perfect system in itself; but such is not the fact. No comparative anatomist, from Cuvier to Owen, has done more than to trace some connexion between extinct and existing races; none has ever attempted to form a system from the fossils of extinct races. No such system could have been formed; and hence, there has been but one creation. Between the productions of the different parts of that one creation there could be no vast space of time,* and, consequently, the six days alluded to in the Mosaic narrative, were but ordinary days, and not indefinite periods, amounting to myriads or millions of years, as modern geologists imagine.

Though geological theories are, for the most part, at variance with Scripture, yet geological facts are not so, nor is Scripture adverse to geology. Religion has no cause to apprehend the progress of knowledge. Physical truths tend only to confirm the truths of revelation, if proofs from science can be supposed to add new evidence in favour of Christianity. Religion has ever been the best benefactress of science; and there exists no reason why the truths of revelation should be opposed to the truths of physical science. None but the enemies of both would employ one to subvert the other.

Astronomy was formerly the subject of much discussion, because its principles seemed opposed to the literal meaning of Scripture. Geology is now in the same predicament, and its discoveries are supposed to be incompatible with the Mosaic account of the creation. But as the truths of religion can never be disproved by those of science, the discoveries in astronomy, or the facts which geology unfolds, can never be opposed to the doctrines which Infinite Wisdom has revealed. A wrong interpretation of Scripture, or an unwarranted inference drawn from erroneous data, may seem to bring religion and science into collision; but conclusions, strictly scientific, are never inconsistent with the Catholic doctrine of Scripture interpretation. The motion of the earth, and quiescence of the sun, are opposed to the literal meaning of Scripture; but the figurative meaning of the text which ascribes a relative, and not an absolute motion to the sun, simply reconciles Scripture and astronomy. In geology, however, the case is quite different; the figurative meaning is not required to reconcile the Mosaic narrative with any truth which that science discloses, for the literal meaning is in perfect accordance with all its phenomena, as an attentive perusal of the following pages will fully demonstrate.

Finally, this work is unreservedly submitted to the judgment of the Church; for however specious the arguments may be in support of private opinions, such opinions must ever be erroneous when, in the slightest degree, opposed to the doctrines of the Church, "the pillar and ground of the truth."

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* See chapters xx and xxi of this work.

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PRELIMINARY REMARKS.

When novel theories in science seem to contradict the written word of God, timid Christians are alarmed, and infidels exult in the vain anticipation of triumph. But fears for the truths of religion, and delusive hopes of its overthrow, are alike groundless. An All-wise and Omnipotent God could never have revealed what science should subsequently falsify. The infidel can have no reason to glory, nor the Christian to apprehend; for whether the new opinions be true or false, they invariably serve to confirm revelation. If true, they tend to increase the sum of our proofs in favour of Christianity; if false, the truths of Scripture shine forth with renewed brilliancy and lustre, like the sun emerging from the clouds, in all the blaze of his meridian splendour.

In every department of human art or science, the progress to perfection is slow and gradual. Man attains not his object at once; progressive steps lead to its final accomplishment. We should not, then, be surprised if, in his attempts to explain the phenomena of nature, he is deceived and frequently errs. But it is, indeed, remarkable, that men of high intellectual attainments should, in many instances, be the abettors of the most absurd theories; and, indeed, of such theories, philosophers, in all ages, have been the strenuous supporters. They devise systems to harmonise with their own preconceived opinions, and these systems are, in their turn, overthrown by others, sometimes less absurd, but generally not less erroneous. Truth may, however, be the final result, as the history of astronomy so strikingly exemplifies. System succeeded system for centuries. The complicated epicycles of Ptolemy, and the long-exploded system of Tycho Brahé, were invented to explain the phenomena of the heavens. The Copernican system, and the discoveries of Newton and Herschel, followed; and though, at first, philosopher was opposed to philosopher, and the pastors of the Church differed in their astronomical opinions, yet the contending parties were reconciled, the written word of God was inviolably preserved, the truths of astronomy admitted, and the Copernican system, so long advocated by Galileo, finally established.

The novel opinions introduced by Copernicus and Galileo, about the beginning of the sixteenth century, occasioned alarms similar to those now felt about the discoveries in geology. The motion of the earth, and the quiescence of the sun, seemed to many, then, as much opposed to the literal meaning of Scripture,* as the deductions from geological discoveries seem now to the Mosaic account of the creation. Explaining the text, in the former case, by the apparent motion of the sun and the absolute motion of the earth, reconciled Scripture and astronomy. Explaining the Mosaic narrative, in the latter case, by admitting the days of creation to be indefinite portions of time, not natural days, as the text would seem to imply, has been adopted by many to reconcile Scripture and geology.

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* It may be well to notice a dangerous error into which the unwary may be betrayed, as it has many advocates eminent for literary acquirements: principles strictly correct when applied to arts and sciences, may be the reverse as regards faith. Progressive steps bring man's work to perfection; in faith, such is not the case. Man's limited faculties compel him, as it were, to attain his object by gradual advances. A God-man has founded a Church and given a law which must be unchanged and unchangeable. His works cannot, like those of man, be liable to improvements. A fixity of character marks the works of God; constant fluctuation is the characteristic of man's inventions. It is, therefore, an error to imagine that perpetual variations in faith lead to the truths of religion. The very reverse is the fact: one error in faith begets another still greater; nor is there any security in doctrine, save in that *one* true faith which the Son of God himself has revealed.

Whether geological discoveries absolutely require such an interpretation, is as yet the point at issue. Some hold this interpretation as indispensable to geology; others believe the literal meaning compatible with all the discoveries hitherto made in the science. But were the facts of geology such as to require the figurative meaning of the text, that figurative meaning might be adopted consistently with the Catholic principle of Scripture interpretation, without sacrificing one article of faith, or relinquishing an iota of Catholic doctrine.

Certain portions of Scripture admit of various interpretations; other parts can only be understood in the figurative sense: to several passages the literal meaning alone is applicable. The sacred volume is not a treatise on natural science; it sometimes speaks popularly, and adapts its language to circumstances. How unintelligible, we may add, how absurd, would it have been to address an illiterate people in words calculated to convey the idea of the sun's fixity, and of the earth's annual or diurnal motion! How strange to a person ignorant of the architecture of the heavens to hear motion ascribed to the moon, and quiescence to the sun, when to his untutored mind both appear subservient to the same law! How few are there, even now, to whom such language would not be a mystery? Had Josue spoken of the sun and moon in the language of modern astronomy, every sentence would have been a paradox even to the most learned of the Jewish doctors. Popular language, therefore, and popular language only, should be used in Scripture wherever questions of physical science are introduced.

Were any of these sciences made the subject of revelation, where would be the terminus? If the knowledge of an Archimedes, a Galileo, or even of a La Place or a Newton, marked the extent of scientific information, how meanly should we think of the dispensation which confined to such narrow limits, sciences which we know to be in their nature illimitable? Physical truths are, therefore, wisely left to the discovery of human reason; and hence, the words of Scripture which allude to the apparent motion of the sun and moon, are those which common sense as well as inspiration would dictate.

But when the inspired writer alludes to a matter of fact, and not to a question of physical science, the case is quite different. We cannot understand the Noachian deluge, or the passage through the Red Sea, in any other than the literal sense. To controvert such facts, would be as directly hostile to Scripture, as were the attempts of Julian the Apostate to falsify the prophecies of our Blessed Redeemer and of Daniel, by his vain and impious effort to rebuild the temple of Jerusalem.

The creation of the world by Almighty God is an article of faith to which every Christian must assent; but the time or manner of that creation is not so. The inspired writer affirms the creation to have been instantaneous: "He that liveth for ever and ever created all things together;"* and Moses insinuates as much, in these words: "In the beginning God created heaven and earth."† But the subsequent verses of the same chapter show a successive development of each distinct portion, in six ordinary consecutive days. This is the simple, literal meaning of the text; but modern geologists, and those who implicitly credit geological deductions, repudiate this meaning, and affirm each of those days to be an indefinite portion of time, consisting of myriads or millions of years.

We are not among those who imagine they forward the cause of religion by a sweeping denunciation of everything that in science or literature seems opposed to the literal meaning of Scripture. We believe that all science is calculated to uphold religion, and that more danger results from an ignorant and reckless condemnation of science, than from the cultivation of its most abtruse departments. No one can be a greater enemy to religion than he who brings it in direct opposition to facts or science. Indiscreet zeal, or ignorant prejudice, may be productive of greater evils than open hostility. It is not, therefore, our intention to depreciate geology; on the contrary, we are anxious to favour its progress, and to fix that science on a rational and permanent basis, by divesting it of the fictitious, useless, and objectionable matter wherewith it is encumbered. Our proofs, therefore, to show the Scripture narrative to be in strict unison with the principles of science, and the natural laws by which the visible creation is governed, imply no objection to the facts of geology, or to the scientific arrangement of the various strata which compose the earth's crust. The unjust deductions from those facts, alone constitute the subjects to which we make exception.

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* Eccles. xviii. 1. † Gen. i. 1.

And is there not reason to complain, when an opinion entertained for nearly fifteen centuries by the whole Jewish nation, and for eighteen centuries by the Christian world, should now be branded as a "vulgar error," and that denouncement made while many of the most eminent geologists are at variance on several important matters connected with the science; while modern geologists overturn without scruple the systems of their predecessors; and while theologians, who make some concessions in favour of these novel opinions, are opposed by others, who deny altogether the conclusions arrived at by modern philosophers?

It is highly unjust to assume as established, the identical proposition most important to be proved, and to stigmatize as a vulgar error the long-admitted opinion of millions. But, as men in power have their parasites, so, philosophers have theirs, to trumpet their opinions, regardless, or, perhaps, really ignorant of their intrinsic value. The opinions of ancient philosophers were widely circulated, merely because they originated with those great men; the notions of modern geologists are also disseminated throughout the length and breadth of the land, because the name of a Lyell or a Buckland can be adduced in their support.

The organic remains discovered in the strata forming the earth's crust, have furnished data for all modern theories; and it must be confessed, that no department of science presents more serious difficulties than those involved in the system of geology. Nor is it probable that these difficulties will be altogether removed until additional proofs confirm more strongly the opinions now entertained, or a more correct application of the knowledge we now possess, force itself upon those already, perhaps, too much prepossessed in favour of opinions put forward by popular writers, and supported by the most eminent geologists of the present century.

The facts which geology discloses, were at first made subservient to infidel purposes, and they even still are data for many dangerous errors; but a science so useful to arts and agriculture, should not be condemned on account of the misapplication of its principles, or the irreligious purposes to which it may have been perverted by ill-designing men. We, accordingly, deem it a duty, in our efforts to reconcile Scripture and geology, to mark the distinction between authenticated facts and unwarranted inferences; to promote the interests of geology, and discountenance idle theories; to grapple with the difficulties of this abstruse subject, and to treat the opinions of those who dissent from our views, with all the indulgence which can be accorded to erroneous notions. We feel that acting differently would increase the difficulties which beset geology, and only injure the cause which we have undertaken to advocate—inadequately, it is true, yet sincerely—for the sake of religion and truth.

CHAPTER II.

Extent to which the earth's crust has been explored—Position of strata—Forms of stratification—Primary, transition, secondary, tertiary strata—Igneous and aqueous rocks—Classification of stratified rocks—Fossils of carboniferous group—Reptiles of the new red sandstone group—Oolitic fossils—Periods of the tertiary formation—Mastodon, megatherium, mammoth—Successive development of animal and vegetable life—Geological epochs.

THE greatest perpendicular depth from the surface of the earth which has been explored by man, is exceedingly small when compared with the distance to the centre. The deepest mine, or sea-coast section, or mountain-chasm, scarcely affords a partial view of the earth's crust to a thousandth part of its semidiameter. Beyond this limit we can have no certain knowledge either of the internal structure of the earth, or of the matter composing it. Inferences drawn from the estimated density of the whole mass, or from the matter emitted by volcanoes, must be more or less conjectural; and, certainly, no arguments based on conjectural data should weigh against the written word of God. Such as established facts supply ought alone to be admitted: others may be allowed all the merit they are entitled to; but inferences deduced from *supposed* operations within the bowels of the earth, and which may or may not have taken place, for aught we can determine, cannot justify those who set aside the plain and obvious meaning of the Scripture narrative.

Geologists say, that the various strata which form the outermost part of the earth's crust, occupy determinate situations with respect to each other: thus, to use geological language, layers or rocks* which belong to a later formation are never found beneath what are called the earlier strata. One species of rock is uniformly found lowest;† the next in the order of its position, rests upon this; and each group of strata occupies its own proper place, from the lowest in order even to the surface of the earth. These stratifications do not extend round the earth, their continuity being broken by their own inequality of thickness, by the ocean, and other causes; yet there are sufficient facts to prove that each stratum, in every country, is similarly situated with respect to the others. Modern geologists have divided these into five classes or groups of formations, constituting altogether about twenty different forms of stratification.

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* In geology the term *rock* is not limited to the stony part of a stratum; it embraces the whole mass, whatever be its composition, or its degree of hardness.

† Several exceptions to this law have lately been established.

The first class, or the *primary* rocks, are those which lie lowest or nearest the centre, and were, until very recently, deemed the oldest or first formed, and hence the name of *primary*.*

Were we to suppose each layer to extend round the earth, the second class, or the *transition rocks*, are those which would be immediately above the primary. The third class, called the *secondary*, would cover the transition. The tertiary would be next in order, and above all would be, what is termed *alluvial matter*, which is composed of sand, clay, and various other accumulations.

Any one of these orders of rock may be at the surface of the earth; but whenever any of the earlier strata† are uppermost, those of a later formation are wanting altogether;

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* Lyell calls the primitive, transition, secondary, and tertiary strata, the "*ancient divisions*," a term not yet obsolete. "These," he says, "have gradually become less fitted to represent the present state of our knowledge. It was imagined they followed each other in regular chronological order, and that the primary were always older than the transition; the transition more ancient than the secondary, and the secondary than the tertiary strata. This opinion, though generally correct, is not strictly true in regard to the entire series, called primary." And yet, in this fluctuating state of the science, even before the *terms* of our theories are fixed, decisions are made, and conclusions arrived at, on some of the most important points. Is this just? It will be shown further on, that the types of all existing rocks are coeval. Earlier and later formations are used as geological terms.

† Dr. M'Culloch states, that a considerable mass of granite in the isle of Skye is incumbent on limestone and shale, which are of the age of the English lias. The limestone at a great distance from the granite contains shells, but exhibits no trace near the junction.

so that if granite be at the surface, it would be in vain to expect limestone beneath it.*

The *primary* strata consist of masses of crystallized rock, generally of the granite kind, which cover a great portion of the earth's surface, and may be considered as the most universal strata, forming, as it were, the floor upon which all the others rest. To this class belong, granite, gneiss, protogine, &c., which are also called plutonic rocks; primitive limestone, mica-slate, and clay-slate, called metamorphic rocks. All these primary rocks are unstratified, and contain no organic remains.

The *transition rocks* are more or less stratified: they derive their name from the supposition that they were formed when the earth was passing into a habitable state. They are said to contain fossils of plants and animals of the simplest kind; as ferns, polypi, and shell-fish. The rocks of this series are clayey slate, transition limestone, sandslate, &c.

Secondary rocks are supposed to have been formed from the destruction of the older rocks, and are deposited in hollows and depressions of the earth. In these are found remains of petrified plants and animals. The rocks of this formation are divided into four groups: 1, The *carboniferous* group, consisting of old red sandstone, mountain-limestone, shale, sandstone, and coal. 2, The *new red sandstone* group, containing rocksalt, red conglomerate, variegated sandstone, &c. 3, The *oolitic* group, consisting of lias, sandstone, oolite, &c. 4, The *chalk* group, made up of weald clays, greensand, chalk, &c.

The *tertiary* strata lie in basins of the chalk and other secondary formations. It abounds in shells, plants, and skeletons of large animals. The rocks of this series are, plastic clay, coarse limestone, gypsum, millstone, and marl-beds. The London and Paris basins are of this formation. It is also extensively developed in the valleys of the great rivers and lakes of the European continent. Above all these lie clay-beds, gravel-beds, peat, and vegetable soils.

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* In reference to the stratified rocks, Phillips observes, "It is evident that our best classifications of the series of stratified rocks can only be locally exact, and authors of such arrangements must be prepared to see them rejected, as in many cases inapplicable or very inconvenient."—Vol. I, p. 124. The justice of this remark has been strikingly exemplified in the arrangements of Werner. They will be found to be no less so in Lyell's classification of the strata of England.

The volcanic rocks are lava, trap, or trachyte, obsidian, basalt, dolomite, augite, porphyry, toadstone, &c.

Igneous rocks include the plutonic and volcanic series.

Aqueous rocks consist of all those which are supposed to have been deposited by water. In this order are included the transition, secondary, and tertiary strata. The metamorphic rocks are supposed to have been produced by the agency of fire and water. They are ranked by some geologists with the aqueous rocks.

The fossils of the transition strata are sea-weeds, ferns, and a few others like those which are produced from seeds of a single lobe, and exist only in deep and marshy grounds. The animal remains are those of the polypi tribe, and shellfish of various kinds, some of which, from their peculiar conformation, were evidently destined to live at the bottom of deep seas. From the situations in which the remains of these creatures are found, geologists infer that they must have existed millions of years anterior to the creation of man. In the carboniferous group, it has been affirmed, that three hundred kinds of plants have been discovered, all of extinct species. These are chiefly of the fern tribes, with many allied to the pine and palm families. The animal remains of this group are zoophytes, mollusca, crustacea, and sometimes a few fishes.

The vegetable fossils of the new red sandstone and carboniferous groups, are similar, but the animal remains widely different. Reptiles of enormous size, and strange forms, are said to have peopled the earth at the period of this formation. The ichthyosaurus, the plesiosaurus, the iguanodon, the pterodactylus, the megalosaurus, the megatherium, the palæotherium, the anoplotherium, &c., were the most remarkable.*

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* The ichthyosaurus, as it is supposed, had the head of a crocodile,

The fossils of the oolitic group resemble those of the former. The cretaceous strata contain fresh-water fossils. The change of appearance exhibited by the tertiary fossils, presents a striking contrast. No vestiges of mammalia, either aquatic or terrestrial, are found in any of the lower strata. Alternations of marine and fresh-water deposits form a novel feature in this division.* The family of pachydermata, to which the genera palæotherium and anoplotherium belonged, was the most remarkable. Cuvier reckoned nearly fifty species of this family. The tapir is the nearest living type of this class of creatures.

Through what are known as the formations of the earlier tertiary periods, vast quantities of fossils, the remains of extinct species of existing families, have been found; and in many instances, the extinct species belonged to families now also extinct. Only in the latter periods, the traces of ruminant animals are discovered. To this period the great mastodon is referred. For a time this animal was regarded by some as an extinct species of elephant, and by others

the body of a fish, with four paddles, not unlike those of a whale. It is supposed to have been, in many instances, thirty feet long.

The plesiosaurus had a long neck, like the body of a serpent, with the head like that of a lizard. Its paddles were longer and more powerful than those of the ichthyosaurus. The iguanodon, a monster of the crocodile tribe, resembled the iguana of South America, or the gavail of the Ganges.

The pterodactylus had the wings of a bat, the neck of a bird, and the head of a crocodile. Its eyes were of enormous size; long hooks projected from its wings. It was, perhaps, the strangest of the extinct race of monsters.

The megalosaurus resembled a lizard, and sometimes attained the length of fifty feet.

These, and a great variety of other singular monsters, are supposed to have been the former inhabitants of this globe. It is, however, hard to prove that the exact form of the living animal, its nature, habits, &c. can be truly ascertained from a foot-print, a bone, a tooth, or even from an imperfect skeleton. Indeed, there is no fact on record to establish this case.

* This appearance in the tertiary formations is the natural result of the alternate occupation of certain localities by fresh and salt water, as would occur by the destruction of fresh water lakes, by rivers, floods, &c. The absence of these appearances in the lower strata proves them not subject to such changes, and, consequently, argues against the total change of continents and of the ocean-bed. Further on, it will be shown how the fossils of the lower strata have been supplied.

as belonging to the hippopotami race; but, at present, it is considered as distinct from either. The remains of this animal are found in great quantities in the low marshy grounds of North America. A skeleton, nearly complete, was dug up on the banks of the Hudson river. The mastodon seems to have been the largest of all the fossil animals whose skeletons have been found complete. The megatherium also belongs to this period. This strange monster had the head and shoulders of a sloth, was cased in a coat of armour like the armadillo, and was equal in size to the largest elephant.

The *mammoth*, or fossil-elephant, is referred to the diluvian era, which geologists fix to the period immediately preceding the present order of things. Remains of these animals abound in Siberia. They are very numerous along the beds of the Lena, Volga, Don, and other northern rivers. Some few have been found in frozen ice in a state of preservation, the flesh, and even the hair, entire.

The geologists who advocate the gradual development of organic life from the simplest to the most complicated forms, and the comparatively recent origin of man,* deem the discovery of the remains of *quadrumana*, both in France and in England, a fact of importance, imagining they are thus enabled to trace a gradual advance through each succeeding stratum. In the earliest strata, the remains of the plants and animals discovered, are of the simplest kinds; those of higher structure are the next; and these again are succeeded by what are deemed of higher order in the scale of creation. The monkey tribes, which form the step above the common order of the mammalia, and below the human race, at length are found; and thus geologists trace the scale of progressive creation from the simple polypi to man, the highest in the scale of animal existence.

These various orders of rock are supposed to belong to distinct geological eras of vast duration; and the peculiar organic remains which each stratification exhibits, are referred to different creations coeval with the strata in which they are found; and hence geologists rashly conclude, that the period assigned by the inspired law-giver of Israel to the existence of this world, cannot be reconciled with the recent discoveries in this new science.

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* Sir H. Davy is a warm advocate of both opinions; but Lyell affirms the "first proposition, though very generally received, to have but a slender foundation in fact:" he, however, admits the second, namely, the recent origin of man, as indisputable.

CHAPTER III.

Parallelism of scripture and geology—Ancient theories—Buffon's hypothesis—Refrigeration of the earth—Whiston and Halley's hypotheses—Ancient philosophers—System of Werner—Theories of Hutton—Systems of modern geologists—Whence deduced—Opinion of Dr. Buckland—Formation of igneous rocks—Stratified rocks—Relative ages of rocks.

Some modern writers, anxious to reconcile Scripture and geology, affect to trace some parallelism between the Scripture narrative, and the gradual development of organic life in its advances to greater perfection. This graduation seems to them as exhibited in each stratum, in an ascending order, from the lowest to the surface of the earth. On this subject Cuvier remarks, " The books of Moses show that he had very perfect ideas respecting several of the highest questions of natural philosophy. His cosmogony, especially considered in a purely scientific point of view, is extremely remarkable, inasmuch as the order which he assigns to the different epochs of creation, is precisely the same as that which has been deduced from geological considerations."

Were Moses an ordinary writer, such observations might, indeed, tend to strengthen his authority; but they cannot be so regarded when we consider him as the inspired lawgiver of God's own people. No encomiums on his philosophical knowledge can increase the credit of his writings, or secure for geological theories a more favourable reception. This supposed analogy between Scripture and geology, seems, in reality, intended to confirm, as it were, by Scripture authority, the opinions so arbitrarily maintained by geologists. If the gradual development of organic life could be established by the aid of Scripture, it could then be used to subvert the authenticity of Scripture, whenever the sacred writings were opposed to any inference resulting from these theories, and would furnish a case analogous to one in which a prisoner was required to bear testimony to the unexceptionable character of the evidence on which he himself was arraigned.

Had philosophers paid more deference to what the great law-giver of Israel teaches, we would never have heard of the absurd and extravagant errors into which many of them have fallen.

Ancient philosophers never pretended to form theories without supporting them by arguments, and these arguments have been, in many instances, overturned by others equally erroneous and ill-founded, though more plausible. It is precisely so with the earlier geologists, whose opinions form the ground-work upon which the theories of their followers have been raised; theories which future discoveries cannot fail to overturn.

The modern notion of an internal fiery nucleus, is but a modification of the exploded theory of Buffon. This naturalist supposed the earth to be a portion of the sun, struck off from that luminary by the collision of a comet; and that when it assumed its present form, it was one liquid mass of fire. He grounded his arguments in support of this notion on the vitrified and vitrifiable substances which he imagined to exist in the forms of sands and clays in the body of the earth.

The refrigeration of the earth from a former high degree of temperature, and the existing central fluid mass of fire, are modern opinions, evidently founded on the theory of Buffon, and adopted by geologists to enable them to account for the formation of igneous rocks, and for the former supposed high temperature of those regions in the temperate and frigid zones, whose organic remains are believed to be the relics of plants and animals of tropical climates.

Whiston imagined the earth to have roamed for numberless ages through space, until the period of the creation, as recorded by Moses, when its orbit was fixed, and its revolution, as a planet, commenced. To account for the deluge, he supposed that the earth, in passing through the tail of a comet, consisting of an aqueous atmosphere, had attracted this transparent fog, which descended in rain upon the earth; and thus he explains what is signified in Scripture by "the cataracts of heaven, which were opened." Dr. Halley supposes the agitation of the ocean, produced by the shock of a comet, to have occasioned the deluge. Burnet imagined a vast reservoir of water within the bowels of the earth; and the deluge to have been caused by the bursting of the frail crust which enclosed it.

The prevalent notions now regarding the destruction and re-formation of continents,* the countless lapse of ages which this earth is supposed to have existed, its nebulous origin, &c.† are not less erroneous than the former, although the arguments in their favour are more plausible, and more ably supported.

It would be foreign to our purpose to notice the numerous absurdities of other philosophers, whose theories have long since met the fate they so justly merited; but those of Hutton and Werner cannot be passed over in silence, as they form the basis of all modern geological theories.

The Wernerian system supposes that the surface of our globe presented at one time a chaotic mass, in which the materials that compose its solid parts were held in solution by water. By chemical attraction, certain portions of these materials formed an aggregate mass of crystals, which consolidating, were precipitated, and formed our primitive class of rocks. A nucleus being thus formed for subsequent deposits to rest upon, the transition, secondary, tertiary, and other strata, were deposited from the waters. The latter formations being partly composed of the debris or disintegrated fragments of the older strata, have less of the crystalline appearance, and are arranged more generally in parallel layers. When the waters had ceased to cover the latter formations, the crust of the earth was prepared for supporting animal and vegetable life, and received from the hand of nature families of both in abundance.

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* The changes produced in the earth's crust by rivers, oceanic currents, volcanoes, earthquakes, &c., are noticed at much length in Lyell's geological works, to show that our continents have repeatedly changed, and will continue to do so *ad infinitum*. These facts would have been better applied to prove, that all geological phenomena could have occurred by natural causes within the period assigned by the Mosaic narrative.

† Dr. Buckland is one of the most zealous supporters of the nebulous theory.

But, to account for the position and structure of the secondary trap-formations, Werner and his followers supposed the waters again to resume their former bed, and the earth to be a second time invested with the chaotic fluid. After this catastrophe, the waters again retired from the earth, and left the dry land for the plants and animals that now cover it.

The hypothesis of Hutton is, that the present dry land was formed from the ruins of a pre-existing continent; that the portion of the globe which we now inhabit, was the bottom of the sea, when, to form it, the older continent was decaying; that our present world is but one of an indefinite series of worlds which existed in times past, and which are destined to appear hereafter; that the solid parts of the earth are suffering decay from the action of the elements, and are borne down to the ocean; that by the action of an internal heat, the strata deposited at the bottom of the ocean from the debris of a former world, were fused, and, in the act of cooling, consolidated into crystalline masses, and thus made to assume the compact structure of mountain-rocks; that the matter, at first arranged in a horizontal direction, being softened by this assumed internal heat, and, finally, indurated by the same principle, it was also, by this element, raised from the bottom of the sea, to form the dry land. By this hypothesis, the shattered surface of the earth, the chasms, dislocations, the various positions of strata, and almost every other phenomenon, are explained.

To obviate objections arising from the dissipation of volatile substances by heat, Dr. Hutton had recourse to another hypothesis, namely, the modifications to which bodies subjected to enormous pressure, as well as to great heat, are liable. This hypothesis is adopted by modern geologists, and found to be very important in supporting the Plutonian theory. With regard to the order of time in which the different strata were formed, the Wernerian and Huttonian theories are widely different. The former makes granite the earlier stratum; the latter ranks it with the later formations. Hutton conceives it in a state of fusion to have burst the external crust in which it was enveloped, and to have issued forth from its furnace like lava from a volcano.*

Modern geologists, aware of the difficulties attending such opposite systems, in which similar conclusions are arrived at by data so different, and also perceiving the absurdity of attempting to explain all existing phenomena by either hypothesis, have formed a modified theory, composed, as it were, of the "worn-down materials" of the Neptunian and Plutonian systems.

Dr. Buckland considers the nebular hypothesis "the most simple, and, therefore, the most probable theory respecting the first condition of the material elements that compose our solar system. Assuming that the whole materials of the globe may have once been in a fluid or even in a nebular state from the presence of internal heat, the passage of the first consolidated portions of this fluid or nebulous matter to a solid state, may have been produced by the radiation of heat from its surface into space: the gradual abstraction of such heat would allow the particles of matter to approximate and crystallize, and the first result of this crystallization might have been the formation of a shell or crust composed of oxidated metals and metalloids, constituting various rocks of the granitic series, around an incandescent nucleus of melted matter, heavier than granite, such as forms the more weighty substance of basalt and compact lava."* Thus, it appears that Dr. Buckland, in common with many other modern geologists, supposes that a large class of rocks owe their origin to igneous fusion, and were formed at great depths in the earth, and under such pressure as prevented the gases they contained from escaping or expanding: the matter of which they are composed having been at first reduced to a liquid state by heat, it then crystallized slowly while in the act of cooling.

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* London Encyclopædia, article 'Geology.'

So far the Huttonian theory is adopted by modern geologists; but, in the formation of the metamorphic rocks, the hypotheses of Hutton and Werner are united. This class of rocks is supposed to have been derived from the granitic family. The matter whereof they are composed, after having been worn down from the pre-existing class by the mechanical and chemical effects of the elements, was deposited by the ocean, and subsequently indurated by great heat from below, and, in its reconsolidation, acquired much of that crystalline texture which it had in its primitive form. Others suppose that the older rocks are gradually being changed to metamorphic by pressure and heat, and thus the different plutonic rocks are supposed to have been formed. Lyell admits "that nothing strictly analogous to these crystalline productions can now be seen in the progress of formation on the earth's surface;"† and yet, their igneous origin is universally admitted by geologists.

In the formation of stratified rocks, the Wernerian theory is assumed. The secondary, tertiary, and all the later formations, are supposed to have been deposits from water. The *grauwacke* group, the lowest of the secondary rocks, appears to connect these with the crystalline masses beneath, as they exhibit traces of deposition as well as marks of chemical formation like those which they overlie. They are, as it were, the link between what are termed the primary and secondary strata.

The rocks deposited by water are referred to the geological epoch which marks the organic fossils they contain.* If, then, the formation of primary rocks according to the geological theory must be admitted, the indefinite age of the earth must also be admitted as the necessary consequence. If stratified rocks have been deposits from water, the periods of such deposits must be incalculably remote. And as the fossil contents of each class of strata must be coeval with the formation of such strata, the days of creation, considered as natural days, would not afford time for such results; and hence, the Scripture narrative and the facts which geology reveals, would be totally irreconcileable.

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* Buckland's Geology; vol. i, p. 40.

† Lyell's Elements of Geology, p. 15.

Such are the general propositions, and such the conclusions arrived at by geologists. They deduce similar results from the separate consideration of each distinct stratum. These strata will be separately noticed in the following chapter.

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* "In determining the relative ages of rocks, three principal tests are adopted; viz., superposition, mineral character, and organic remains. If the strata are horizontal, the bed which lies uppermost is the newest, and that at the bottom the most ancient."—Lyell's Elements of Geology, p. 272.

CHAPTER IV.

Theories of early geologists—Modern theories—Origin of strata—Theories of coal formation—Examples to illustrate these theories—Chalk and silica—Formation of soils—Effects of the atmosphere in the disintegration of rocks—Quartz—Fossil-shells—Origin of basalt and greenstone—Fossils found in high latitudes—Central heat—Inferences—Different classes of writers—Unwarranted inferences of geologists—Phillips' remarks on inductive geology—Reply—Remarks of Dr. Buckland—Conclusion.

Buffon and many of the older geologists commenced their theories by stating their notions about the origin of the earth; but modern philosophers are more cautious. These are silent on this subject, and commence with the production of igneous rocks. Phillips says, that "it is not meant to affirm that the materials of which these rocks consist, have not existed together in any other combination, or been subject to other conditions previously;"* but he makes no allusion to what that previous condition could have been: on this point we are left to mere conjecture.

The materials of the stratified rocks are supposed to have been obtained from the debris of the older series; but how all the distinct formations which now exist even in the same localities, could have been arranged by water from the confused mass which might have been contained in that element, either in solution or suspension, is not satisfactorily explained by modern theories.

It is true that mechanical deposits from water will be arranged in layers according to the specific gravities of the materials; but stratified rocks in the secondary and tertiary beds do not follow this law. The coal-measures contain alternate layers of coal, sandstone, limestone, shale, ironstone, &c. How such different deposits could have been made on the same spot, is not easily conceived; nor will the modern theory of coal-formation explain the mystery. This mineral is numbered with the carboniferous group, yet no philosopher has ranked it with the aque-

* Phillips' Geology, vol. ii, p. 44.

ous formations; a new theory has been specially invented to account for the origin of coal, and it must be allowed, that many cogent reasons are adduced in support of its vegetable origin. Coal alternates with various other minerals, and is supposed to consist entirely of vegetable matter. The intervening strata are all aqueous deposits. Some coal-fields contain a great many beds: those of Kilkenny, eight; those of Newcastle, no fewer than forty.

To form these beds, vegetable matter is supposed to accumulate in some dense forest for many years, perhaps for many ages; then, this forest becomes the bottom of a gulf or lake, until the vegetable matter is covered with a deposit from the water in which it is submerged. This deposit, in the lapse of time, becomes a mass of rock. Again the land is raised, and covered as before with vegetables; again submerged, and covered with another layer of rock; and this alternating process is supposed to have continued as often as there are beds of coal in the district or coal-field.*

Others imagine, that several rivers, flowing into a gulf or lake, brought with them the matter which constitutes the coal-measure; one brought the mud of which the shale was formed,—another the vegetable matter to compose the coal,—a third brought materials for forming limestone;—and so of the other beds. Were any of these theories true, the indefinite length of the days of creation could not be doubted, and we would be compelled to interpret the Mosaic narrative figuratively.

As examples to illustrate the first hypothesis, the submarine forests on all our coasts are cited.† The second hypothesis is said to be " beautifully exemplified" by the deposits now being formed in the delta of the Mississippi. We will, however, test these evidences as we proceed in our inquiries.

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* A *coal-field* is the district in which coal is found; *coal-measure*, the beds of coal and other minerals in the coal-field.

† An eminent chemist and geologist, deputed by the British Association, in 1843, to examine the coast at Youghal, reports, that "a submarine forest extends, at least, half a mile under the bay, and is now covered by a dense layer of sand, over which the *Bar* is being formed. When the turf is pierced through for six or seven feet, it is found that the under stratum is passing into a bituminous coal, and rests on another bed of shingle and sea-shells; and lower still, another

Chalk, when subjected to minute microscopical examination, is said to consist almost entirely of the shells of animalcula, and is supposed to have been formed like the coral of the South Sea. Silica, too, when examined by the microscope, exhibits similar traces of animal remains. The shells and skeletons of certain animalcula, being deposited at the bottom of the ocean, formed the silicious rocks, which were subsequently raised by some geological event, and thus the silica of the mineral world, which constitutes about 45 per cent. of all the rocks with which we are acquainted, is said to have been formed. Had silica been produced in this manner, a much longer period than 6000 years would be required.

The formation of soils is supposed to furnish another fact to corroborate the arguments in favour of the indefinite age of the world. Granite-rocks are not so compact as to prevent water from penetrating the pores which lie between the particles that compose them. This water, in the act of freezing, expands, and the fissures are widened. Again, they admit more water, and, again, the expansion of the ice which winter forms, widens them still more; and by a series of such operations the rocks are disintegrated. The particles, so separated, are carried off by rain, and deposited in valleys, or on horizontal surfaces. When the crystals of the granite are separated, and the felspar dissolved, the silica, potash, alumina, &c., are carried off; and thus are many soils formed. The length of time necessary to form, in this manner, all the soils now in existence, should be incalculably great; and here again, geology, and the literal meaning of the Mosaic narrative, are quite at variance.

The atmosphere is another powerful agent in the decom-

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bed of turf, of a depth not yet ascertained, is said to exist." From these facts he infers, that we have here an example of the rising and subsiding of this district exactly corresponding with what other geologists report of coal-fields. We will account further on for these strata by a more rational theory.

position of minerals. The oxygen of the air, acting on such as contain iron, causes more changes than may, at first, be contemplated from such a seemingly passive agent. The basalt of the Giants' Causeway contains crystals of a mineral called *olivine,* upon which carbonic acid acts with surprising effect. The exterior of these rocks is of a brown or yellowish colour, soft and easily broken, while the interior of the same rock is greenish and hard, so as to strike fire with steel. Other volcanic rocks are liable to similar effects from the same cause.

Simple rocks, such as quartz, resist these causes, but are worn down by the mechanical action of seas, rivers, &c. The length of time necessary to form soils by such means can scarcely be conceived.

Fossil-shells, of forms such as now abound in the sea, are met with far inland, both near the surface, and at all depths below it, as far as the miner can penetrate. They occur at all heights above the level of the ocean, being observed at an elevation of from 8000 to 9000 feet in the Alps and Pyrenees, more than 13000 feet high in the Andes, and above 15000 in the Himalayas. These shells belong mostly to marine testacea, but in some places to forms characteristic of lakes and rivers. From these and similar facts, geologists infer, that present continents must have been sea-bottoms at some former epoch, as such could not, according to their views, have been the result of any temporary deluge, such as the Noachian.

The pyrogeneous origin of basalt and greenstone is inferred from numerous cases, in which it is found, that where coal and bituminous shale come in contact with these rocks, the coal is often turned into coke, and the dark shales assume a very light colour. If this be so, and if coal be a vegetable production, the length of time necessary to give them their present form, must be very great indeed; as the period required to convert wood into coal, together with the previous time necessary to form the vast accumulations of vegetable matter for this purpose, must have been absolutely immense.

The organic remains discovered in high latitudes, and which appeared to have belonged to tropical climates, demonstrate, in the opinion of modern philosophers, some extraordinary changes of temperature not known within the historic period, and which, on that account, must be referred to epochs long anterior to the creation of man, and, therefore, incompatible with the Mosaic account.

The central heat of the earth is assumed from the changes of temperature observable in descending into deep mines; from the high temperature of mineral and thermal springs; and from the heat of the water ejected from artesian wells. If the existence of this central heat be admitted, the gradual refrigeration of the earth will follow as a consequence, and its original incandescent state can scarcely be denied; and here also the discoveries of geology clash with the narrative of Moses.

Similar inferences are deduced by geologists from each of the other groups of strata, as well as from each distinct layer.

The successive creation of animals and vegetables is inferred from the fact, that each stratum has its own peculiar fossils, which are, in most instances, different from each other, many of them having no analogous species now existing on earth. Phillips observes, that " the marine organic contents of each system of strata are the remains of successively created and destroyed races of animals, each of which lived through particular periods of time, and no longer."* This is also the prevalent opinion of other geologists.

Arguments deduced from marks in sandstone, supposed to be the foot-prints of animals, and from many other facts of minor importance, will be noticed hereafter.

The inferences drawn from these facts, in reference to Scripture, have been very different, the religious opinions of each class of writers, rather than the facts of geology, forming the bases of the different theories. Those who, like the apostate Julian, impiously attempted to falsify Scripture, availed themselves of geological discoveries to overthrow Christianity; and hence, the word *geology* has long been a term of distrust with many.

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* Geology, vol. i, p. 153.

Those anxious to reconcile the Scripture narrative with these discoveries, adopted the figurative meaning of the text, as a legitimate means of effecting their object; while many eminent theologians, perceiving the text too plain to admit a figurative interpretation, explain it in the literal sense, admitting at the same time, in order to meet the difficulties of geology, a previous state of existence, in which animals and vegetables had flourished upon earth long before the creation of the existing races.

Such are the leading facts of this science, and such the inferences drawn from them. These inferences would, in almost every case, be conclusive, were the premises unobjectionable. But geologists have erred in a variety of ways: rash opinions are adopted, and theories framed to accord with those opinions; extended inductions, insufficient data, and mere conjecture, supply, in many cases, the place of scientific demonstration, or conclusive argument; and that this is no unfounded assertion, we refer the reader to some of the numerous opinions contained in the voluminous works of Lyell, where conclusions are arrived at from no better data than what *may*, or what *might*, or what *could* have formerly occurred.

For example, in accounting for the phenomena of tertiary formations, he says, " When the area under consideration began to be converted into land, a very different condition of things *must succeed*. A series of subterranean movements *might* first give rise to small rocks and islets, and then by subsequent elevations to larger islands by the junction of those first raised. These lands would consist of mineral masses, whether coralline, sedimentary, or volcanic. The degradations of these would commence immediately upon their emergence; so that new strata would begin to form in different places at the bottom of the still remaining seas, and by continued rising and sinking of different parts of the bed of the ocean, distant basins would be formed, in which different sediments *might* accumulate. Some of the groups of islands that had at first risen, would, in the course of ages, become the central mountain-ranges of the continents."* Again he observes, that "in some regions in the north of England and Scotland, where marine mountain limestone alternates with strata containing coal, such an arrangement of the beds *may possibly* have been produced by the alternate rising and sinking of large tracts, which were first dry land, and then submerged again."† Yes, and they *may possibly* have been produced otherwise. If what may possibly have occurred, be allowed to have occurred, we may prove or disprove what we please. Proofs of this kind might be multiplied almost without limit, not only from the works to which we have referred, but from the writings of other geologists. We will do so occasionally as we proceed, even at the risk of being numbered with those against whom Phillips inveighs in the following terms: "It is true that the blind opposition to the progress of inductive geology, based on an erroneous view of the true meaning of the Scriptures, derived from the days of ignorance, should be wholly abandoned; and perhaps the consideration of the proof furnished in the Isle of Portland may be sufficient to relieve, at least, some of the unreasonable pressure which geology feels from sources where it should meet hearty encouragement."‡

With us it is a duty to the cause we advocate, to point out the discrepancies of modern theorists; and though such differences of opinion may extend but to minor circumstances, and in nowise alter the general results at which they arrive, yet they are important, inasmuch as they tend to show that implicit confidence cannot be placed in the truth of conclusions drawn from conflicting hypotheses, which will, in their turn, be rejected by future geologists, with as little ceremony as we now discard the extravagances of Burnet, Whiston, and other early geologists.

Dr. Buckland complains that "it is argued unfairly against geology, that because its followers are as yet agreed on no complete and incontrovertible theory of the earth, and because early opinions, advanced on imperfect evidence, have yielded in succession to more extensive discoveries; therefore, nothing certain is known upon the subject, and that all geological deductions must be crude, unauthentic, and conjectural."

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* Geology, book iv, p. 365.

† Ibid. vol. i, p. 197.

‡ Geology, vol. i, p. 143.

While we agree with the learned doctor, that such arguments applied to geology as a science, would be very unfair, and while we admit, besides, that differences of opinion do and must exist in every department of science, without invalidating the general results; yet, when geologists advance opinions on "imperfect evidence," and while they are "agreed on no complete and incontrovertible theory," and under these circumstances denounce opinions maintained for centuries by the most enlightened individuals of all Christian countries, as "an erroneous view of the true meaning of the Scriptures, derived from the days of ignorance," we imagine it can neither be unfair nor uncalled for to investigate the merits of the new theories, to point out their numerous discrepancies and absurdities, and to repudiate inductions which no circumstances connected with geological science can warrant; inductions inadmissible in any department of science where demonstration is required, or in any argument in which logic or common sense is valued.

CHAPTER V.

Rival theories—Objections to the Wernerian and Huttonian hypotheses—Modern systems—Production of igneous and metamorphic rocks—Volcanic rocks—Central heat—New hypothesis—Evasive arguments—Origin of matter—Advocates of central heat—Objections to modern theories—Central fiery mass, and external ocean—Experiments—Conclusion.

THAT the same set of strata should be supposed as derived from the opposite elements of fire and water, is a result alike unfavourable to the Wernerian and Huttonian theories, the arguments in favour of each hypothesis being equally gratuitous and equally liable to such serious objections, that no implicit credit can be given to either.

It is true, that modern geologists adopt neither the Neptunian nor the Plutonian theory, altogether; but it is equally true, that the theories of the present day are, in many respects, fully as objectionable as either. The difficulties involved in the older theories, as noticed in the following extracts from the London Encyclopædia, are, in all points, as applicable to modern opinions. " The second class of operations, in the order of succession, according to the Huttonian theory, is the process of consolidating, deranging, and elevating the earth's crust, formed at the bottom of the sea; and the second great principle it assumes is, the agency of internal heat for accomplishing these purposes. By employing this agent, and assigning it so important functions, the Huttonians have exposed their system *to objections evident to the least acquainted with geological speculations*, and which the most able Huttonian cannot satisfactorily remove. The first thing that strikes us as a difficulty in the conception of this theory, is the immense volume and intense force of that heat which could melt or soften masses so gigantic in bulk, and so infusible in nature, as those composing the habitable world.

" But there are objections to the principle in this theory of a different kind, and not so easily answered. What is the nature and source of this central heat? and what are the laws regulating it? These are questions, in the answers to which, the supporters of the Plutonic system are certain to involve themselves in difficulties, if not in contradictions. Does this heat arise from combustion? No; for combustion requires conditions for its existence which are not to be found in the circumstances under which this central heat is supposed to act. Where could such a quantity of combustible matter be found as could fuse and eject those mighty chains of mountains, which extend so far, and rise so high? If combustible substances should be found in the magazines of nature, whence could come that gas which is necessary for this operation? The circumstances of compression under which this central heat is supposed to act, and the consequent exclusion of oxygen or atmospheric air, are sufficient to destroy every idea of combustion.

"It should be observed, however, that the ablest adherents of the Huttonian hypothesis have entirely renounced the use of fuel in the production of the central heat, and have resorted to other means of exciting and supporting it. Most of them, also, have given up the solar rays, friction, and condensation. Indeed, the supposition on which Mr. Playfair, the ablest supporter of the system, finally rests, seems little else than the old doctrine of occult qualities. If his hypothesis has any meaning, it implies that an immense heat was originally stored in the lower parts of the earth, and that it is there preserved by the mutual action and reaction of the bodies in which it resides, upon each other.

"But its preservation in the same volume and intensity without any fresh supply, is contrary to all laws by which the action of heat is regulated. Indeed, the simple idea that the central fire has softened the strata which were formerly cold, mechanical deposits, presupposes a new distribution of its influence, with a consequent decrease of intensity in its original repository; and thus, the very purpose for which its operation is assumed, cannot be accomplished without destroying the necessary conditions of its existence."*

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* London Encyclopædia, vol. x, p. 111.

A leading objection to the Wernerian system is grounded on the following evident principle; viz., that "the formation of the beds of strata, by a successive deposition from water, would lead us to expect that the separate layers should be deposited horizontally, or that they should, in their whole extent, be arranged at right angles to the force of gravity; that they should be continuous or without fissures, and that they should have neither elevations nor depressions. The reverse of this, however, is the fact. Instead of universal horizontality, we frequently find them almost in a vertical position; instead of a continuous surface, like the coats of an onion, we see wide, irregular rents and fissures; and, instead of a uniformly level appearance, we find mountains and alpine chains shooting up many thousand feet above the surrounding regions. In a system that lays claim to consistency, some explanation must be provided, for reconciling these apparent anomalies with its general principles."*

To give such explanation is the evident object of modern systems, and for this purpose the Wernerian hypothesis is in part retained, as best suited to elucidate those strata denominated aqueous deposits. But the Huttonian theory accounts with a far greater show of plausibility for the vertical and oblique positions of strata, for rents, fissures, dislocations, elevations, depressions, and all the phenomena so strikingly exhibited wherever geological inquiries have been prosecuted.

The Wernerian and Huttonian hypotheses being no longer tenable, and the modern system of geology being, in a great measure, composed of the least objectionable portions of both, it is just to examine how far it answers the ends proposed by its advocates.

It is almost needless to allude here to the manner in which igneous and aqueous rocks are supposed, by modern geologists, to have been formed, as all recent works on this subject are very explicit on the point. Mr. Chambers says, that "Plutonic rocks are supposed to have been formed at great depths in the earth, the matter having been originally in a hot and soft state, afterwards cooled and crystallized slowly, under such enormous pressure as prevented the contained gases from expanding.

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* London Encyclopædia, vol. x, p. 112.

"It is supposed that the matter of metamorphic rocks, derived from rocks of the granitic kind, and suspended in vast oceans, was, when deposited, subjected to a great heat from below, which gave it, in its reconsolidation, much of that crystalline texture which it had in its plutonic form."* That many rocks have been produced by heat generated in the bowels of the earth, we readily admit; and that many others have been produced from aqueous deposits we are equally willing to grant; but to suppose that *all* rocks owe their origin to such causes, is absurd. Volcanic rocks, the products of heat derived from causes which the "chemical hypothesis" explains, are natural, and of ordinary occurrence; but to imagine the granitic family of rocks "*may* have been derived from the fusion of previously-formed strata,"† is a position, we think, no scientific scholar should assume.

Many modern geologists suppose the interior of the earth to consist of a mass of liquid fire, the external crust being, in Dr. Brayley's opinion, from eight hundred to a thousand miles in thickness;‡ though Cordier, Ware, Fox, and others, suppose the maximum thickness not to exceed a hundred. To this central heat, many of the geological phenomena which modern research has discovered, are attributed. The formation of primary rocks, and the reconsolidation of the metamorphic, are among the leading effects. The theory of those formations presents many serious difficulties.

Concerning the matter of which these rocks are supposed to have been formed, we are told no more than that "it is now only necessary to admit, that through whatever previous conditions the matter of which they consist, has passed, their last combination, in which they now appear, has been caused by the agency of heat."§

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* Information for the People—Geology.

† Phillips' Geology, vol. ii, p. 45.

‡ Dr. Brayley's Geological Lectures, delivered in June, 1844.

§ Phillips' Geology, vol. ii, p. 45.

Primary rocks being *unstratified*, of a *crystalline texture*, and containing no organic remains,* it became necessary, in order to give some show of consistency to modern theories, that some hypothesis should be framed to explain these peculiarities. That of Hutton was adopted. Now, a theory fashioned to correspond with the notions of the theorist, and to suit a particular object, has no claim to that confidence which a theory previously established, and subsequently applied to the solution of a difficulty, merits. Were we at liberty to form theories of this kind, we could have no difficulty in unravelling the most intricate problems. We should not, then, admit new opinions without subjecting them to the most rigid scrutiny, for such opinions frequently involve greater difficulties than those which they are intended to obviate.

The case under consideration is a striking instance; for surely it is less objectionable to suppose that the Almighty Being, who by a *fiat* drew all things out of nothing, created granitic rocks as they now appear, than to adopt the geological theory of rock-formation, which is fraught with endless difficulties, and to which no rational solution can be given, save that which the act of creation alone supplies. This act by creative power, is conformable to reason and religion; while geological theories involve consequences alike repugnant to the laws of nature and the obvious meaning of Scripture, as well as to the strict principles of inductive science. To these, the remarks of Lyell, on a different subject, are strictly applicable.

He says, "No sooner do we study and endeavour to explain submarine appearances, than we feel, to use a common expression, out of our element; and, unwilling to concede that our extreme ignorance of processes now continually going on, can be the cause of our perplexity, we take refuge in a *pre-existent order of things*." It is precisely so in a multitude of other cases: philosophers unwilling, under any circumstances, to plead ignorance on questions of natural science, are sure to form peculiar notions, and to adapt their theories to these preconceived ideas:—such the effects of intellectual pride.

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* Phillips, however, observes, that "all the tertiary and secondary strata, and some of the (upper portions) primary strata are *rich in organic fossils* of the animal and vegetable kind."—Geology, p. 47.

If, as geologists say, primary rocks were formed by the agency of central heat, there existed at the period of this formation none of the later strata: there were no transition, no secondary, no tertiary, no sands or soils, on the surface of the earth. All was water, and the matter whereof the primary were formed. But the matter which constituted these rocks had a previous existence. In what state we are not told by modern geologists. Whether as rocks, or earths, or soils, we know not. How long this matter had previously existed—what changes it had undergone—what combinations it had formed—on all these we are left in total ignorance.

In whatever state we consider matter to have existed previously to the formation of primary rocks, the same round of unmeaning inquiries must again be repeated in order to account for the manner in which it had arrived at that state;—whether by the formation of still older rocks than the plutonic—whether by the decomposition or disintegration of these—and whether the elements of fire and water had been the agents in those exceedingly remote operations. And after all these conjectures—for they can be nothing else—we must finally conclude that matter came from the hands of the Creator in some particular state, which state, whatever it might be, will be as liable to geological speculations, as the existing order of things; —or, that matter is eternal, and has been eternally undergoing new modifications. This latter no Christian can adopt, being as impious as it is absurd; for, as a learned writer remarks, " no created object could have been from eternity, and were matter from eternity, it should have been *uncreated:* and as this is an attribute of the Deity alone, it cannot, without blasphemy, be ascribed to any other object in existence."

But to suppose the earth, such as it now is, to have been so created, is opposed neither to reason nor to science —admitting, at the same time, those natural changes and revolutions to which matter, in whatever state it exists, must be for ever liable.

But to return to this theory. If the nucleus of the earth was at first a mass of liquid fire, whose external crust being composed of matter which, by the action of the internal heat, was converted, under enormous pressure, into plutonic rocks, as the advocates of central heat affirm, whence could the enormous pressure be derived? The other strata then were not formed, and those primary rocks must have occupied the exterior of the earth's crust, and if so, what could have prevented the gases from escaping or expanding? In such a case, as all geologists admit, no rocks could have been formed. It may be said, that the ocean supplied the necessary pressure. Even so, the theory is liable to serious objections: within, a sea of fire; without, an ocean of water; and between both, a process of rock-formation going on. Who can countenance such extravagance?

The gases of the intermediate matter might have been prevented from expanding by the pressure of the superincumbent ocean, but the heat of that mass would be communicated to the waters in immediate contact with it; the heated waters would ascend, and a stratum of cold water from above would occupy its place, and thus the temperature of the ocean-bottom would have been kept far below the degree at which rocks would fuse.

Besides, it is evident that the quantity of the latent heat carried off from the central mass by an ocean converted into steam, would cool down even the internal fiery nucleus in a period of time far short of the imaginary epochs of geologists, particularly as no means of renewing the wasted heat is supposed to have existed. The steam thus formed, on parting with its heat in the upper regions of the atmosphere, would condense and fall back again into the ocean, again to be formed into steam, and this process repeated *ad infinitum.*

Should it be supposed that plutonic rocks might have been formed at a still lower depth than the bottom of the ocean, and not in contact with the waters above, the difficulty of accounting for the matter which separated the internal sea of fire from the external sea of water, will remain; and were it even possible in the order of nature, that such a state of things could have existed, and that primary rocks were so formed, the geological process by which the primary rocks and the superincumbent matter subsequently changed place, requires to be explained. Those primary rocks are, in fact, the great floor upon which all the strata of the earth's outer crust rest at present, and if the later formations, or stratified rocks, be supposed to have been formed of this matter, then, again, the theory which ascribes the materials of stratified rocks to the debris of the primary ones, will be opposed to such an idea.

The absurdity of this imaginary system of rock-formation is further confirmed by the following observations on Mr. Daniel's recent experiments of the heat of bodies. "At their point of fusion, he invariably found that it was impossible to raise the heat of a large crucible of melted iron, gold, or silver, one single degree beyond the melting point, as long as a bar of the respective metal was kept immersed in the fluid portions. So in regard to other substances, however great the quantity fused, their temperature could not be raised, while any solid portions immersed in them, remained unmelted; every accession of heat being instantly absorbed during their liquefaction. These results are no more than the extension of a principle previously established, that so long as a fragment of ice remained in water, we cannot raise the temperature above 32°. If, then, the heat of the earth's centre amount to 450,000°, as M. Cordier deems highly probable, that is to say, about 20 times the heat of melted iron, even according to Wedgwood's scale, and upwards of 160 times according to the improved pyrometer, it is clear that the upper parts of the fluid mass could not long have a temperature only just sufficient to melt rocks. There must be a continual tendency towards a uniform heat; and until this were accomplished by the partial interchange of the fluids of different densities, the surface could not begin to consolidate. Nor can we, on the hypothesis of primitive fluidity, conceive any crust to have been formed until the whole planet had cooled down to about the temperature of incipient fusion." Again, "If the central heat were as intense as is represented, there must be a circulation of currents tending to equalize the temperature of the resulting fluid, and the solid crust itself would be melted; hence, such a state of things seems wholly inconsistent with the laws which regulate the circulation of heat through fluid bodies."*

These remarks, so conclusive against the opinion that unstratified rocks owe their origin to a *central heat*, or to the nebulous origin of the earth, are equally applicable to disprove the existence of such a central heat, or of any former universal incandescent state of the earth.

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* Lyell's Geology, b. ii, chap. 18, pp. 360, 373.

CHAPTER VI.

Origin of plutonic rocks—Tests of antiquity—Recent granites—Lyell's arrangement of strata—Relative ages of rocks—Fossils, and mineral characters of rocks—Granitic veins—Granite incumbent on other strata—Effects of recent granite—Basalt and greenstone—Trap-dykes—Granite of Norway—Granite and secondary rocks of the Hautes Alpes—Granite of Dartmoor—Dip or strike of strata unaltered by the intrusion of granite—Gneiss and granite of Christiania—Difficulties in determining the age of plutonic rocks—Varying theories.

The granitic rocks were supposed by the advocates of the Wernerian theory to be the earlier formation, while those of the Huttonian, on the contrary, maintained them to be the later. Many modern geologists, with Hutton, suppose them to be of igneous origin, but, with Werner, account them the older formation. Chambers says, that "the plutonic, and some of the lower metamorphic rocks, have been called primary, or primitive rocks, as either the first formed of all, or formed very early;"* and all modern geologists agree, that some of the plutonic, at least, were the first formed, for very recently-discovered facts are of such a nature as to require that some granites be considered late formations. Superposition being the principal test for determining the relative ages of strata, and granite forming the floor or bed upon which most of the others rested, this rock was naturally looked upon as the oldest, and hence it was inferred, that when granite was next the surface of the earth, it would be vain to expect what were deemed later formations beneath it.

But there have been instances in which limestone was found under granite, and instances, too, in which other rocks containing organic remains, have been found enclosed in granite. Chalk containing such remains, is said to occur in portions of the granite of the Hartz mountains. To explain these phenomena, some modification of the igneous rock-formation theory became necessary, and accordingly, Lyell proposes the following as the most plausible.—

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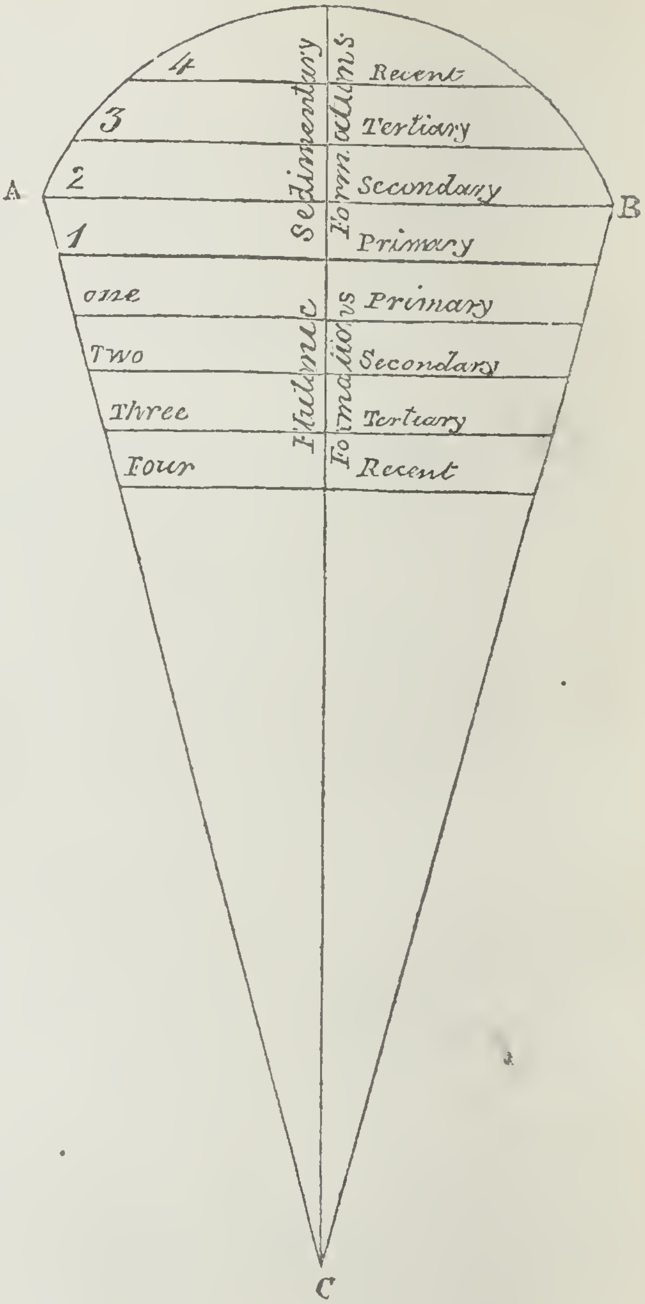
* Information for the People,—article 'Geology.'



Let A B represent a portion of the surface of the earth, C, its centre; 4, 3, 2, 1, are the aqueous formations; *one, two, three, four,* the plutonic formations. He calls the *primary plutonic* the oldest granite; his *secondary plutonic* lies under this; the *tertiary plutonic* next; and the *recent plutonic,* lowest of all. The *primary sedimentary* strata he supposes to have been first deposited on the primary plutonic; the secondary sedimentary strata on these, and so on to the surface, as in the diagram.

By this arrangement the antiquity of the different orders of formations is fixed, and superposition is made the principal criterion by which their relative ages are determined. The mineral character of the sedimentary strata may in some cases assist, but in the plutonic rocks there can be no other criteria save the mineral character and superposition, as this class contains no organic remains.

In using the mineral character as a test of antiquity, there should be some fixed, some indubitable standard, to which reference might be made. In Lyell's hypothesis of plutonics, there is no such standard, and rocks which occupy a certain position are *assumed* as the oldest. His arrangement is entirely arbitrary.

In the sedimentary formations which contain organic remains, superposition is the test by which the relative ages of the *great groups* or classes of rocks are determined. From their *position*, we make the *transition* older than the *secondary*, and the secondary older than the tertiary; and having thus fixed the relative antiquity of these groups, the antiquity of their fossils is the natural result.

Here, then, geologists determine the antiquity of fossils by the classes of rocks in which they are found; yet, in treating of the subdivisions of these groups, the organic remains are made the test for determining the ages of the rocks, that is, the relative ages of fossils are determined by the strata, and the antiquity of the strata, by the fossils they contain. By this *vicious circle* is the modern system of geology demonstrated.

The strata of the London and Paris basins are referred to the same epoch, on account of their organic remains, though in their mineral character they are totally different. The oolite series of England, parts of the Jura, Alps, and other distant regions, are also made coeval, because some of the organic remains are the same, though the lithological resemblance is altogether different. "In those cases," remarks Lyell, "where fossils vary, the mineral character of the rock often remains constant; and on the other hand, the fossils are sometimes uniform throughout spaces where the lithological nature of the rock is variable. In this manner we are frequently enabled to prove the contemporaneous origin of the same formation by one test when the other fails."* This is, in fact, proving the antiquity of rocks by fossils, and of fossils by rocks, as occasion requires.

But, returning to the facts which have induced geologists to consider granite a recent formation, we may mention as the principal, the granitic veins which intersect other strata in every direction. "The importance of this class of veins," says Dr. M'Culloch, "is important, as by means of them it has been shown that granite, though inferior in position, is of more recent formation than the schistus incumbent on it; and that the latter, instead of having been quietly deposited on the former, has been, long after its deposition and consolidation, heaved up from its horizontal position by the liquid body of granite forcibly impelled against it from below."*

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* Elements of Geology, p. 295.

"No part of the world," says Phillips, "equals Cornwall in the abundance of opportunities afforded by its sea-cliffs, streams, and mines, for studying the veins which, at almost every point, branch off from the great subjacent masses of granite into the everywhere incumbent *Killas*."† And M'Culloch states, that in the island of Skye, a considerable mass of granite is incumbent on limestone. These facts, which seem calculated to overturn the notion that granite was the first formed, as well as the lowest stratum of those which constitute the outermost rind of the earth's crust, geologists account for, by supposing that masses of *recent plutonic*, effused from below in a fluid state through the superimposed granitic formations, penetrated the sedimentary strata, and formed what is termed the *recent granite.*

This hypothesis was devised to account for the granitic veins; for the presence of fossils in rocks enclosed in granite; for granite incumbent on limestone, and other aqueous formations; and for other phenomena disclosed by geological research, such as the conversion of limestone and chalk into fine, white, grey, or red marble; of coal into coke; and for the effects produced on shale and other stratified rocks.

But the truth of a theory is not established, however satisfactorily it may explain particular facts. False systems of astronomy afforded plausible solutions to some of the leading difficulties of that science; and systems of philosophy long exploded, were, in many things, seemingly just. The principle on which the first air-balloons were constructed, was erroneous, though the result was calculated to elicit a very different conclusion. Thus, the theory of the formation of recent granite may be untrue, although ingeniously devised to show causes why those singular appearances observable on shale and other stratified rocks, should exist.

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* Illustrations of the Huttonian Theory, p. 312.

† Geology, vol. ii, p. 77.

" One of the most popular of all the proofs of the pyrogeneous origin of basalt and greenstone," says Phillips, " is exhibited in Keylodyke, which crosses the Tweed below Lennel : here the coal-seams intersected by it are converted into a sort of cinder, the bituminous matter having been entirely dissipated. Several of the dykes in the collieries of Newcastle and Durham have expelled the bitumen from the coals and shales to various distances, according to the width of the dyke, and other less known conditions of the adjoining strata. It is a general fact, that the carboniferous substances which are associated with any part of the primary or transition strata, are of the nature of anthracite, devoid of bitumen."*

Striking as these facts may appear in proof of the igneous origin of granite, they are nullified when opposed to other facts of equal notoriety. " At Mulvagh Bay," says Sir R. Kane, " the beds of coal are six in number, of which four are bituminous, and two anthracitous. The latter are found one immediately above and the other close below a range of columnar basalt of seventy feet in thickness, which lies in among the coal-strata. It might appear that these beds also had been originally bituminous, and that the basalt injected at an intense heat had distilled off their volatile portions, converting the residue into anthracite. There are, however, other strong reasons against such an idea. Thus, the beds of coal which *lie close under the upper range of basalt, are fully bituminous,* and the effect of heat shown where trap-dykes traverse the bituminous beds, and convert them into true coke, is quite different from anything visible in the lower beds, which consist of real anthracite."†

Were it really the case that part of the Newcastle and

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* Geology, vol. ii, pp. 97, 98.

† Industrial Resources of Ireland.

Durham coal was converted into coke by the trap-dykes of this district, is there not reason to seek for some other cause for producing this effect than that which geologists usually assign?

At Mulvagh, we have a coal-bed *fully bituminous*, though lying close under a range of basalt. Had this basalt been effused from below in a liquid state, how could the coal remain bituminous, and in contact with such a heated mass? If we suppose the coal to have been a subsequent formation, how has some of it been placed close above, and more of it below a range of basalt seventy feet in thickness? If the basalt was injected in a fluid state between the beds of coal, how is it that the anthracite is quite different from the true coke which the trap-dykes are supposed to have formed? These facts are directly hostile to the geological theory.

On this subject, Lyell observes, that " although strata in the neighbourhood of dykes are thus altered in a variety of cases, shale being turned into flinty slate or jasper, limestone into crystalline marble, sandstone into quartz, coal into coke, &c., it is by no means uncommon to meet with the same rocks, even in the same districts, absolutely unchanged in the proximity of volcanic dykes."* Again, he admits that " there are places in the north of Ireland where the chalk is scarcely, if at all, altered by the contact of basaltic dykes, and a similar phenomenon is not unfrequent in other districts."† Lyell's attempts to account for these phenomena are neither satisfactory nor conclusive.

If these facts are not sufficient to prove that *recent granite* was not effused from below in a fluid state, they certainly afford sufficient reason to question the validity of the opposite opinion. But they are not the only facts which can be adduced against the modern hypothesis.

The granite called *recent* is found in localities exhibiting no traces of having been injected into the neighbouring strata. " There are many instances," remarks Lyell, " as at Markerud, near Christiania, in Norway, where the strike of the beds has not been deranged throughout a large area by the intrusion of granite, both in large masses and in veins. This fact is considered by some geologists to militate against the theory of the forcible injection of granite in a fluid state. But it may be said in reply, that ramifying dykes of trap, which almost all now admit to have been once fluid, pass through the same fossiliferous strata near Christiania, without deranging their strike or dip."*

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* Elements of Geology, p. 180.

† Geology, vol. iv.

This is truly a curious proof of the original fluidity of granite. In reality, it goes to prove that the trap-dykes, as well as the granite, were never in a fluid state. If the trap was once fluid, and forcibly injected through incumbent strata, why did it not derange the dip of these strata? It should have done so as well as the granite; and yet, because it has not, we are, forsooth, to infer that fluid granite *might* have been upheaved from beneath, without deranging the incumbent strata. If this proof of the recent formation of granite be admissible, we know not what to reject as unproved propositions.†

The granite and secondary rocks in the department of the Hautes Alpes in France, become, near the point of contact, metalliferous, and contain nests and small veins of blende, galena, iron and copper pyrites. The stratified rocks become harder and more crystalline, but the granite, on the contrary, softer and less perfectly crystallized near the junction. In this case, have we not as good a right to affirm that the limestone affects the granite, as that the granite alters the limestone? In this place "the granite is incumbent, yet we cannot assume," says Lyell,

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* Elements of Geology, p. 213.

† We do not mean to affirm that granitic rocks may not be melted and injected through other strata, by means similar to those by which lava is ejected from volcanoes. But the cases, if any have existed, must be very rare, as it is morally impossible to melt granite in the bowels of the earth, and preserve it unmixed with other extraneous matter; in which case, lava, and not pure granite, would be the injected matter. If, however, granite has been fused, and preserved unmixed when effused from below, the circumstances must be so peculiar, that no impartial geologist will deduce the general inference, that all granitic rocks have been generated in this manner.

" that it overflowed the strata; for the disturbances of the rocks are so great in this part of the Alps, that they seldom retain the position they at first occupied."

Here we have granite incumbent on other strata, and in such circumstances, that even Lyell *cannot assume* it to have been effused from beneath in a fluid state; yet, at all hazards, the theory must be maintained by the assertion, that the rocks do not occupy their original positions. How can it be shown that they have not retained their original positions? Is it because the granite exhibits no appearance of having been forced up? This would be to assume the identical proposition to be proved, namely, that granite has been injected in a fluid state amid stratified rocks; and this is what Lyell actually does in this instance.

" The granite of Dartmoor in Devonshire, which was formerly supposed to be one of the most ancient of the plutonic group, is now ascertained to be posterior in date to the culm-measures of that country, which, from their position, and as containing coal-plants, are regarded as of the carboniferous series. The granite, however, has broken through the stratified formations without much changing their strike."

It should not, we imagine, *much* alter the dip or strike of these strata; for the most probable supposition is, that it never passed through them, and this idea is confirmed by the following passage from the same author:—" The gneiss and granite near Christiania are of different dates, yet, the granite produced after this long interval, is often so blended with the ancient gneiss at the point of junction, that it is impossible to draw any other than an arbitrary line of separation between them. But had such junctions alone been visible, and had we not learned from other sections, how long a period elapsed between the consolidation of the gneiss and the injection of the granite, we might have suspected that the gneiss was scarcely solidified when invaded by the granite. From this example we may learn how impossible it is to conjecture whether certain granites in Scotland and other countries, which send veins into gneiss and other metamorphic rocks, are primary; or whether they may not belong to some secondary or tertiary period."*

The impossibility of determining to what geological era these rocks belong, bears evidence against the existence of any such eras, and is calculated to prove the identity of age of all rocks, at least of the *types* of all existing rocks, and consequently furnishes geological data confirmatory of the Scripture account of the creation of all things together.

But what will the lovers of antiquity think of geological epochs, when they hear one of the most eminent modern geologists declare that "so greatly are our views now changed, that we find it no easy task to point out *a single mass of granite* demonstratively more ancient than all known fossiliferous deposits. Could we discover some lower cambrian strata resting on granite, there being no alterations at the point of contact, nor any intersecting of granitic veins, we might then affirm the plutonic rock to have originated before the oldest known fossiliferous strata. Still it would be presumptuous to suppose, that when a small part only of the globe has been investigated, we are acquainted with the oldest fossiliferous strata in the crust of our planet. Professor Sedgwick and Mr. Murchinson conceive that the granite in Sutherlandshire, near Brora, has been upheaved in a solid form. If we admit that solid hypogene rocks, whether stratified or unstratified, have; in such cases, been driven upwards, so as to pierce through yielding sedimentary deposits, we shall be enabled to account for many geological appearances, otherwise inexplicable. Thus, for example, at Weinböhla and Hohnstein, near Meissen, in Saxony, a mass of granite has been observed covering strata of the cretaceous and oolitic periods, for the space of between 300 and 400 yards square."†

Could the most zealous supporter of Scripture require stronger arguments in favour of the Mosaic narrative, than those which can be inferred from the words just cited? As no single mass of granite can be proved more ancient than some of the fossiliferous deposits, it follows, that primary rocks cannot be proved to have existed prior to the creation of the organic kingdoms. But, as animal remains are found in strata contemporaneous with the oldest rocks which contain vegetable fossils, hence, animals, plants, and primary rocks, are coeval, or very nearly so, as the Scripture indicates.

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* Lyell's Elements of Geology, p. 503.

† Id. p. 505.

If we admit that solid hypogene rocks have been driven up through sedimentary deposits, how can it be shown that such rocks are of recent formation? and if we make no such concession, "geological appearances" will be, in some cases, wholly "inexplicable." Is it not, therefore, "demonstratively" evident, that these geological theories contain nothing opposed to the obvious meaning of the inspired volume, especially as it would be "presumptuous to suppose that we are acquainted with the oldest fossiliferous strata in the crust of our planet;" and in these circumstances, is it not presumptuous to assert, that geological facts are in any way opposed to the Scripture narrative?

At one period, granite is supposed to be a primary rock, the lowest in position and the oldest of the series; other rocks are, however, found beneath it, and the theory is modified to suit the discovery. Some granites are then said to be recent formations, and to have been upheaved in a fluid state, and in this case to become incumbent on other strata. New discoveries are made, recent granite is found without those veins deemed so necessary to prove its original fluidity, and to meet this stern fact the recent granite must come ready-made to the surface; otherwise, geological appearances will be utterly inexplicable.

But this is not all. A new idea, which is daily becoming more popular, is now entertained by many: namely, that all the plutonic rocks have been formed by the gradual melting down of the stratified ones, and hence that transition rocks are identical with the stratified rocks higher up in the series. When or where these speculations will terminate, we cannot conjecture; but future discoveries will probably produce corresponding alterations in these theories. The attempts hitherto made to demonstrate the relative antiquity of rocks, are vague, inconclusive, and, in many respects, highly objectionable.

The last-mentioned theory would seem plausible, could it be shown that at any former period a series of stratified rocks enclosed a central fiery nucleus; but this is to explain one difficulty by another still greater. Who can conceive how a series of such deposits could have been made? Are we to imagine an ocean of water precipitating aqueous rocks on a mass of liquid fire, and this burning nucleus converting those formations into primary and crystalline rocks? Such an idea would be absurd, and yet it is the only way, according to the theory, in which we can imagine those strata to have been originally formed. We regret that geology should be identified with such extravagant notions.

CHAPTER VII.

Animal and vegetable kingdoms—Mineral world—Organic and inorganic bodies—Consequences—Geological chronology—Tests of geological epochs—Doubts and discrepancies—Systems of organic life—Opposite opinions of Buckland and Phillips—Effects of heat—Agents in rock-formation—Fossils in primary rocks—Metamorphic rocks—Links of connexion between different formations—Insufficiency of geological data to mark the scale of time—Unfair use of Scripture—Antiquity of stratified formations—Errors of Werner—Lyell's geological periods—Rival sects—Voltaire and geologists—Legitimate inferences.

Animal as well as vegetable life is found to exist under every conceivable form, and in every variety of circumstances. Beings, even of the same species or variety, differ from each other in several particulars; and yet, philosophers evade to account for the causes of all the diversity of colour, taste, smell, form, &c., in vegetables; or of forms, habits, dispositions, &c., in animals. It is true, that every one can account for these things in the only rational way they can be known, namely, that they have been *so created* by Almighty God, who at the same time communicated to material beings all those mutual relations by which the visible world subsists.

But why do not philosophers investigate all those combinations and modifications of matter by which the different parts of plants or animals are formed? The identical process by which food is converted into fish, flesh, blood, bone, hair, feathers, fins, &c., and *how*, in vegetables, the same materials, are changed into leaves, fruits, flowers, or into the more durable portion of the plant? The reason is evident: the task is beyond human comprehension; it involves difficulties which far transcend man's limited capacity, and which, perhaps, no created intelligence can fully conceive.

As regards the mineral world, the case is quite otherwise. Every species of rock, stone, clay, &c., must, geologists say, have passed through various other states before it acquired its present form; and no mineral, not excepting even the metals, is supposed to have retained that peculiar nature in which it came from the hands of the Creator. The Pythagorean maxim, "*Nihil est toto quod perstat in orbe*," is adopted by modern geologists in its fullest extent as regards the mineral world; and such is the passion to account for the existing state of minerals, that he who dares to doubt the most extravagant theory, is regarded as a bigot or a blockhead.

The animal and the vegetable kingdoms are fixed, determinate systems, which depend, in a great measure, on the mineral kingdom for support. This mineral kingdom should, therefore, be equally fixed, at least, as those that depend on it for their existence. It would, in our opinion, be exceedingly strange, and, we will add, unphilosophical, to suppose the mineral world, which constitutes the basis of the other two kingdoms of creation, to be itself the mere effect of chance, as it should be, were fire and water the agents in producing the minerals of the earth's crust, as geologists assert. In that case, *certain* effects would depend upon *uncertain* causes; a principle by no means admissible in philosophy.

Hence, the Creator has not left the production of strata to the contingent operations of the elements. The natural effects which mechanical and chemical agents produce on pre-existing matter, will be noticed hereafter; at present, the geological hypothesis of rock-formation must engage our attention.

It was remarked in the preceding chapter, that superposition was the principal test of the antiquity of rocks; and this opinion is confirmed by the *following passage from Phillips:*[*] "The basis of geological chronology is the succession of stratified rocks; the lowest are the oldest, and the uppermost are the most recent. Unstratified rocks present no such series; yet, by their connexion with the others, these also may frequently be referred to their true dates. On this account, the section of strata in any other country is the foundation of true and philosophical knowledge of its geological history. Smith and Werner produced sections of strata to form the scale of geological time. If it be found, that along any axis of elevation the set of rocks included in the gneiss, mica-slate, clay-slate, and grauwacke-slate systems, are dislocated, but that none of the strata belonging to the carboniferous, or other more recent systems, have participated in the movement, the conclusion is plain, that the disturbance happened before the deposition of the latter rocks, but after the production of the former."

With this passage we will contrast the following from Dr. Buckland: "The mineral character of the inorganic matter of which the earth's strata are composed, presents so similar a succession of beds of sandstone, clay, and limestone, repeated irregularly, not only in different, but even in the same formations, that similarity of mineral composition is but an uncertain proof of contemporaneous origin, while the surest test of identity of time is afforded by the correspondence of the organic remains; in fact, without these, the proofs of the lapse of such long periods as geology shows to have been occupied in the formation of the strata of the earth, would have been comparatively few and indecisive." He adds, "The same formations which in England constitute the argillaceous deposits of the London clay, present at Paris the sand and free-stone of the calcaire-grossier; whilst the resemblance of the organic remains proves the period of their deposition to have been the same, notwithstanding the difference in the character of their mineral ingredients."*

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[*] Geology, p. 66.

These opposite sentiments, expressed by men of such eminence as Phillips and Buckland, will naturally perplex the reader, and make him doubt which opinion to adopt in order to determine the antiquity of strata; nor will he be relieved from his embarrassment by hearing Lyell declare, that he finds it a matter of great difficulty to decide "as to the relative antiquity of the crystalline foundations of the earth's crust, when compared with the fossiliferous and volcanic rocks they support. With regard to the relative ages of these rocks, we cannot hazard even a conjecture on this point, until we know whether, upon an average, the power of water above, or that of fire below, is more efficacious in giving new forms to solid matter.—After these observations, the reader will perceive that the term *primary* must either be entirely renounced, or, if retained, must be differently defined, and not made to designate a set of crystalline rocks, some of which may be newer than the secondary formations."†

Could we require stronger proofs than these to mark the illusiveness of geological theories, as far as they regard different eras? Lyell professes to know not which is more ancient, the crystalline rocks or the fossiliferous strata. If the latter be as old as the former, then we *can* affirm that organic beings are as ancient as primary rocks; though Buckland will make no such admission. Speaking of geological epochs he says, "Having this evidence both of the beginning and end of several systems of organic life, each affording internal proof of the repeated exercise of creative design, and wisdom, and power, we are at length conducted back to a period anterior to the earliest of these systems; a period in which we find a series of primary strata, wholly destitute of organic remains; and from this consideration we infer their deposition to have preceded the commencement of organic life. Those who contend that life may have existed during the formation of the primary strata, and that the animal remains have been obliterated by the effects of heat on strata nearest to the granite, do but remove to one point farther back, the first term of the finite series of organic beings; and then still remains beyond this point an antecedent period, in which a state of total fusion pervaded the entire materials of the fundamental granite, and one universal mass of incandescent elements,* wholly incompatible with any condition of life which can be shown to have ever existed, formed the entire substance of the globe."†

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* Geology, vol. i, p. 3.

† Elements of Geology, part ii, p. 268.

Here Buckland asserts, that whatever be the ages of those strata containing fossils, granitic rocks must be still older, and must have been formed by fire, when animal or vegetable life could not have existed on the surface of the earth.

One evident object seems to influence geological opinion in favour of heat in the formation of primary strata, namely, that fusion obliterates the marks of all earlier states of material arrangement; and thus may the absence of all organic remains in these formations be accounted for. This is, perhaps, what induced a learned doctor,‡ in delivering a course of geological lectures in Cork, (June, 1844), to assert that " marble did contain organic remains, but that these were extracted from it by the sun's rays." Now, as primitive limestone is represented by the marble of Italy and Greece, and as Dr. Brayley asserts, that such marble did contain organic remains, his opinion on this point is directly opposed to that of Buckland, who tells us, that during the formation of these rocks the conditions of the earth were wholly incompatible with the existence of organic life.

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* Such a general state of fluidity by heat, Lyell emphatically denies.

† Buckland's Geology, vol. i. p. 56.

‡ Dr. Brayley, professor of Geology, T. C., Dublin.

From these observations we perceive, that the most eminent modern geologists disagree on points most important to the interests of geology. They can neither agree upon the age, nor upon the origin of strata. The anxiety to render fire and water the agents in producing rocks, has been a fruitful source of inconsistencies.

" Experimental proof has been offered by the chemist," says Phillips, " that quartz-rock is merely sandstone altered by heat."* If so, then secondary rocks are older than primary; for quartz is numbered with primary rocks, while the oldest sandstones are found in the secondary formations.†

M'Culloch states, that organic remains occur in limestone lying in the gneiss-tract of Loch Eribol, in Sutherland; and Hoffman informs us, that fossils are found in gneiss and mica-slate in the Erzgebirge and Fichtelgebirge. Were this the case, geological theories would receive a fatal blow, as this would furnish proof that primary strata contain organic remains; and how such remains escaped obliteration by the fire which fused the matter of those rocks would perplex even geologists to explain. Phillips vindicates the theory by stating, that " Messrs. Sedgwick and Murchison having visited the spot indicated by M'Culloch, failed to confirm his testimony;" and thus, he saves the *theory,* by sacrificing the *veracity* or the *geological discernment* of M'Culloch and Hoffman.

" In considering," says Lyell, " the forms of stratification in metamorphic rocks, their passage on the one hand into the fossiliferous, and on the other into the plutonic formations, and the conversions which can be ascertained to have occurred in the vicinity of granite, we may conclude that gneiss and mica-schist may be nothing more than altered micaceous and argillaceous sandstones; that granular quartz may have been derived from silicious sandstone, and compact quartz from the same materials. Clay-slate may be altered shale, and granular marble may have originated in the form of ordinary limestone, replete with shells and corals, which have been since obliterated; and, lastly, calcareous sands and marl may have been changed into impure crystalline limestone."*

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* Geology, vol. i, p. 76.

† London Encyclopædia, vol. x, pp. 85, 89.

Here it is admitted, that primary rocks may have been derived from shale or ordinary limestone; now, as shale is but indurated clay, and as limestone and chalk consist of the same materials, we may, consequently, aver that primary rocks are derived from clay and chalk; but chalk and limestone are affirmed by many modern geologists to have been produced by animals: hence, primary rocks could, according to these notions, have been derived from animals!

Granitic rocks are said to be of igneous origin, because a passage can be traced from modern lavas to granite. But it can with equal truth be said, that the "crystalline or primary series sometimes passes by intermediate gradations into strata of mechanical origin, containing organic remains. The formations of intermediate character by which that passage was effected, were often observed to partake in a perplexing degree of the character of the crystalline series, and some of these containing fossils."

If it be just to infer that granite is an igneous rock, because a series of gradations connect it with lava; is it not equally just to infer its aqueous origin, because it is similarly connected with this class of rocks by a number of links? Besides, on the authority of Lyell and Phillips, in the passages above quoted, we are given to understand, that many of the primary and metamorphic rocks *might* have been nothing else than aqueous rocks altered by heat.

When, to all this mass of evidence, which clearly proves that little confidence can rationally be placed in geological theories which refer to the original state of things, we add the admission which Phillips feels called upon to make, "that the origin of all natural phenomena is obscure, and that granite *may have been* derived from the fusion of previously-formed strata," we imagine there can be little difficulty in coming to the conclusion, that no rational grounds exist for setting aside the Scripture narrative, and substituting for it the vague and unauthentic epochs of geology.

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* Elements of Geology, p. 245.

Did we need additional proofs to show how imperfectly geological data mark the scale of time, and how inconclusive they are in reference to the age of the world, man's history would supply the desideratum. No fact which this science has yet disclosed, points out the time of man's appearance on earth; and, were we to depend on geological evidence for this important circumstance, the history of our own species would have been as mystical as the traditions of the most barbarous tribes, and as imaginary as the wildest romance.

Phillips admits "the state of ignorance in which we really are" on this point; but neither does he nor any other geologist allude to the unfair inferences deduced from man's creation. They combat Scripture by scriptural arms. They admit the authenticity of Scripture in pointing out man's origin, because geology has failed to do so; but in determining the origin of animals and vegetables, they do not admit the authority of the same Scripture. Man's *recent* origin is shown from Scripture. The *literal* meaning is admitted as far as it regards man; but the *allegorical* meaning of the same text *must* be supposed when plants and animals are the subjects under consideration. Scripture authority is admitted in pointing out the period of man's first appearance on earth, and this identical admission is made use of by geologists to prove the inadmissibility of Scripture as regards the other portions of the visible creation. Geology is made the criterion for establishing the history of by-gone imaginary epochs, in which speculatists may indulge at pleasure in delineating the surface of the earth, and describing its monstrous and singular inhabitants; but where man, or the existing races of organic beings are concerned, this science altogether fails to point out their origin, or to give the slightest outline of their history. Why, then, should we give implicit credit to geological theories in the former case, which we know to be so imperfect in the latter?

Geologists require the aid of Scripture in fixing the origin of man, but reject it when launching out into the wide sea of speculation. Such a mode of acting is neither calculated to inspire confidence in their theories, nor to promote the interests of geology.

The theories which refer to the antiquity of stratified formations, are not more satisfactory than the former. The elaborate works of Lyell, in his description of the English formations, will be found to disappoint the young geologist, who hopes to find *proofs* of distinct epochs in the geological researches which have been made in this limited section of the earth's crust.

Werner was betrayed into errors by forming his theory to suit the observations made in the districts which he examined in Germany; and Lyell has been led into similar mistakes in his eocene, pliocene, and miocene periods, from the English formations. Such series of *risings, sinkings, dislocations, denudations,* &c. &c., is he forced to introduce in his hypothesis to explain the appearances which these strata exhibit, that few who have the patience to wade through his volumes, will enter into his views on the subject. And were it even possible for all his imaginary revolutions to occur in England, his general deductions will be as inapplicable to other districts in distant countries, as were the theories of Werner to the continents of Asia or Africa.

To show that Lyell's conclusions have not received the general sanction of other writers, we subjoin the following remarks of Chambers: "It seems impossible to agree with Mr. Lyell in the subjoined remark on the eocene era: 'When we reflect,' says that writer, 'on the tranquil state of the earth, implied by some of the lake-formed and sea-formed deposits of this age, and consider the fullness of all the different classes of the animal kingdom as deduced from the study of the fossil-remains, we are naturally led to conclude that the earth was at that period in a perfectly settled state, and already fitted for the habitation of man.'" Chambers adds, that "several strong arguments might be adduced against this conclusion."*

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* Information for the People, 'Geology,' p. 29.

Indeed, there exists no just cause for giving implicit credit to Lyell's hypothesis of English formations, nor to those of any ancient or modern geologist. Lyell himself records* the theories of about fifty of the most eminent philosophers of ancient and modern times, and so contradictory are their notions, that the reader cannot fail to be impressed with the most unfavourable opinions regarding their doctrines, especially such as could produce the following results: "Ridicule and irony," he says, "were the weapons more frequently employed than argument by the rival sects (the Neptunists and Vulcanists); till at last the controversy was carried on with a degree of bitterness almost unprecedented in questions of physical science."

Even the impious Voltaire availed himself of these disputes, to use them as weapons of attack against Scripture, when he fancied the facts of geology were enlisted by theologians in the cause of Christianity. "Every one of them," he writes, "destroys and renovates the earth after his own fashion, as Descartes formed it; for philosophers put themselves without ceremony in the place of God, and think to create a universe with a word." Lyell admits, that "such ridicule, directed against early cosmogonists, was but too well merited;" and we regret to add, that modern ones, too, are not exempt from this censure.†

The actual state of the earth's crust might have been examined, the relative positions of strata classified, their mineral characters ascertained, and their organic contents referred to the orders of plants and animals to which they belong, without subjecting the science of geology to all the absurdities in which speculative theorists indulge.

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* Principles of Geology, chap. i, ii, iii, and iv.

† About forty years ago, a German professor published a volume to prove that the pyramids of Egypt are nothing more than basaltic eruptions, magnificent sports of nature, and so many incontrovertible proofs of the general derangement which has taken place on the globe. See London Encyclopædia, vol. xviii, p. 276.

CHAPTER VIII.

Objections to the theory of plutonic rock-formation—Primary and fossiliferous rocks coeval—Origin of minerals—Their various forms and properties—Organic remains, a test of the antiquity of rocks—Reptiles of the wealden group—Wealden beds—Theory of their formation—Homogeneous character of rocks—Fossils common to the wealden beds—Portland "*dirt-bed*"—Its formation—Stratifications of mountains—Sections of sand-hills—Evidence of design in the works of creation—Necessity of elevated regions—Original state of matter—Concluding observations.

NOTWITHSTANDING the arrangement which Lyell has made of the different groups of rocks, in which he supposes the primary plutonic to be the oldest, yet it has been shown that he elsewhere expresses his doubts as to the greater antiquity of this class of rocks, although other geologists hesitate not to pronounce the primary series as the first formed.

If geologists will account only for the existing condition of matter, without pretending to answer for its original state, their systems are imperfect, their theories incomplete, because they account not for the origin, as well as for the progress of natural events. If, in accounting for the present order of things, they involve the former in absurdities, no credit can be given to their assertions, and no confidence can be placed in their theories. How are we to estimate the theory of primary-rock-formations, if the matter whereof they are composed, had been fused by a central fiery nucleus? Had that fusion taken place near the surface of the earth, the *pressure* which could keep the gases from escaping is wanted; if the fusion occurred at great depths in the earth, the *power* which could raise them to the surface is also wanted. If the ocean covered the surface of the earth, the difficulties are increased, as we cannot conceive how rocks could have been formed between an internal sea of fire and an external one of water. Lyell is at a loss for proof to show that plutonic rocks are more ancient than the oldest fossiliferous strata, and, according to the notions of that eminent geologist, primary rocks must have been formed subsequently to the creation of organic beings; for he says, that "there was never a universal ocean since the planet was inhabited, or rather since the oldest groups of rocks yet known to contain organic remains were formed, as is proved by the presence of terrestrial plants in all the older formations."* Now, if there was no universal ocean since the planet was inhabited, and if primary rocks cannot be shown to be older than the fossiliferous, it should follow that primary rocks were formed at some period subsequent to the separation of the sea from the existing land, and, consequently, were formed without the *pressure* of the ocean, that is, were formed at the surface of the land in which they are now found, or deep in the earth. If they were formed at the surface, whence came the *pressure?* If deep in the bowels of the earth, what became of the superincumbent matter? It could not have composed the stratified rocks, as there was no universal ocean since to deposit them; and, besides, geologists affirm them to be composed of the *worn-down materials* of the primary rocks.

The obvious inference is, that geological theories of rock-formation are highly objectionable, and that these very facts which are adduced to establish such theories, only confirm more strongly the truth of the Scripture narrative. Animal remains are found in the oldest rocks which contain vegetable fossils, and fossiliferous rocks are confessedly as old as primary formations. Is it not, therefore, evident that all these were created together, and that the Mosaic account of the creation agrees literally with the facts which geology discloses?

Indeed, the geological theory of stratified rocks is fully as objectionable as that of the unstratified series. "The testacea of the cretaceous group," says Lyell, "amount to about one thousand: if we refer every set of strata in Europe, which are characterized by these organic remains, to one period, we comprehend in it rocks of every variety of mineral composition. In the Pyrenees and in Spain, are found compact and crystalline marbles, masses of gypsum and salt, puddingstones, red sandstones, thin shales and grits containing impressions of marine plants, and other rocks, to which there is nothing analogous in formations of the same age in northern Europe."

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* Principles of Geology, vol. iii, p. 99.

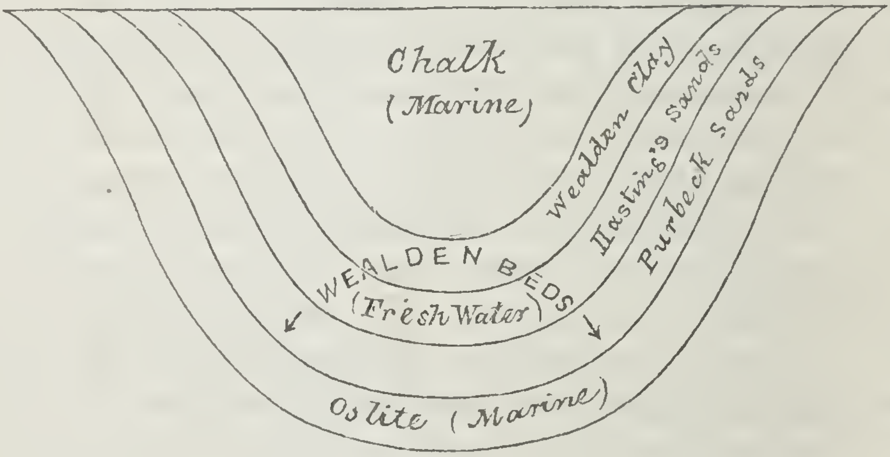
If "rocks of every variety of mineral composition" can be referred to the same period from the organic remains which they contain, surely mineral composition alone will not establish different and distinct geological periods; for, as other rocks in Spain and the Pyrenees can be traced to the same period with formations totally dissimilar in northern Europe, so, likewise, rocks esteemed by geologists still older, may, in other regions, contain similar fossils, and thus be referable to the same era, though in direct hostility to former notions. Organic remains and mineral composition will doubtless point out distinct depositions and distinct formations; but they prove not the existence of distinct geological epochs, or successive creations of organic beings.

In the wealden group of England, the remains of numerous reptiles, and vegetables which exhibit many characters of tropical flora, are found. The iguanodon, judged from its teeth and bones to have been seventy feet in length, is amongst the number. Chalk and greensand repose on the weald-clays; the oolite lies under these. The oolite and chalk are marine, the weald, a fresh water deposit. The chalk and greensand have an aggregate thickness of 1000, and sometimes 1500 feet; the weald-clay, from 800 to 1000 feet. The shells of the wealden beds are almost exclusively of fluviatile or lacustrine genera; those of the chalk and oolite, marine. To form these beds must have required countless ages, according to the notions of geologists; for, when the matter which constitutes the oolite was deposited, the place which it now occupies must have then been a sea-bottom. Subsequently, the space was covered by fresh water. A lake or estuary is supposed to have deposited the wealden beds. After the lapse of ages, the sea again is supposed to have reasserted its dominion, and deposited the chalk-formation, and thus, by an imaginary series of *risings* and *sinkings*, of revolutions and convulsions, the existence of these beds is attempted to be accounted for. Lyell imagines the Atlantis of Plato in some measure necessary to account for geological appearances.

" Though fabulous in history," he thinks " it may be true in geology." Really, the fables of history are as rational as many of the inferences which geologists would have us receive as the established truths of this science.

It must not be supposed that the wealden beds of England lie in parallel layers of several hundred feet in thickness, and that geological observations have been made at great depths, and in such circumstances as to establish the theory of their formation on indubitable grounds. It is no such thing. The incumbent beds are found to lie, as it were, in basins of the underlying strata, as in the annexed figure, in which the beds sometimes thin out to a mere surface at the edges.

When it happens that one description of stratum, as chalk, occupies a portion of a country, and that strata of a different kind, seem to dip underneath it, and reappear at the opposite extremity of the chalk-formation, as in the above figure, it is highly probable that the underlying bed is continuous, and that the chalk reposes in a basin of the stratum below. When geologists examine the strata at the edges, or where the edges thin out, or where a sea-coast or chasm may make them visible, and in these peculiar positions discover organic remains, and refer these



remains to some geological epoch, or conclude them to be of fresh water or marine origin, they then unhesitatingly deduce the unwarranted inference, that all the intervening mass contains similar fossils, and that all have been formed by depositions from water.

It requires very little argument to show that such strata may contain organic remains near the surface, or in a sea-coast section, or deep fissure, though not through the rest of the stratum. "One variety of rock," says Lyell, "is sometimes found exclusively prevailing throughout an extensive district, where it preserves a homogeneous character; so that having ascertained its relative age in one place, we can easily recognise its identity in others, and thus determine, *from a single section*, the chronological relations of large mountain-masses."* This system of generalization has proved as injurious to the interests of geology, as it is unfair and unwarrantable in its consequences. It is easy to conceive how fossils may exist in cliffs, coasts, and sections, which by no means pervade the whole mass; and hence it so frequently occurs in geology, that general theories deduced from isolated facts, are overturned by a single discovery.

It has been already noticed, that mineral character and organic remains are esteemed the principal tests for determining the relative ages of strata. The eocene deposits of England and Paris are referred to the same era on account of their fossils, though no formations are more dissimilar in mineral composition. The oolite, the wealden, and the cretaceous beds are accounted different, partly because their fossils are different, and partly because they vary in lithological character, the fresh-water formation being situated between those that are marine. Were we, however, guided by the test of organic remains, a closer examination of the fossils of these beds may afford sufficient data for referring all to the same period. "Some geologists," says Lyell, "have classed the wealden as a member of the cretaceous group, others have considered it as more nearly connected with the antecedent oolitic deposits; nor is it easy to decide which opinion is preferable, because the organic remains of the cretaceous and oolitic groups are marine, while those of the wealden are almost all fresh water. The testacea and plants of the latter appear as yet to be specifically distinct from those of any other formation; but if we examine the reptiles, it appears that the megalosaurus is common to the oolitic and wealden, the teeth and bones of this great saurian occurring both in the limestone of Stonesfield and in the Hastings sand.

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* Geology, vol. iv, p. 89.

"There are also some generic forms both of reptiles and fishes common to the oolitic and wealden, and yet not discovered in chalk. Vertebræ, for example, of the plesiosaurus are found in the oolite and lias, and also in the wealden; and fish, very characteristic of the wealden, is abundant in the oolitic series, though unknown in the cretaceous group. On the other hand, the same species of iguanodon is decidedly common to the wealden and greensand. The ichthyosaurus and plesiosaurus are found in the lias; but the former is not confined to this formation, but has been found in strata as high as the chalk-marl and gault of England, and as low as the muschelkalk, a formation which immediately succeeds the lias in a descending order."*

The fossils common to these formations, afford proofs as convincing that they are coeval, as the fossils peculiar to each group can supply to demonstrate that they belong to different eras; and hence, it is as just to refer these beds to one period of time as to distinct epochs. But to show how geologists uphold an erroneous hypothesis, we cite Lyell again, in his attempts to account for the variations in the fossils of the oolitic group. "There are variations," he says, "in the fossils of the higher, middle, and lower part of the oolitic series, which must be ascribed to that great law of change in organic life by which distinct assemblages of species have been adapted at successive geological periods to the varying conditions of the habitable surface of the earth."* In this instance we have different organic remains in the same formation, unaccounted for but by adopting the theory of successive creations of organic beings. This is, in fact, assuming the proposition to be demonstrated, or, as it is called by logicians, a "petitio principii," namely, that there have been successive creations of organic beings. Now, if there were no such distinct creations, geologists can assign no reason, consistently with their own theories, for the presence of the different fossils in the oolitic group; and if we assume at present, what we will hereafter prove, viz., that there have been no distinct creations of organic beings different from those produced on the fifth and sixth days, it will appear evident from the fossils of the oolitic and wealden strata, that similar organic remains may exist in rocks of different lithological character, and yet furnish no proof that such formations were coeval; for, in this case, the fossils should belong to the same era, though the rock which contained them might be referred to different periods. We do not mean geological periods of vast duration, but periods consistent with the Scripture narrative, and with the ordinary course of natural events.

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* Geology, vol. iii, pp. 367, 391.

The opinions of geologists in reference to the alternations of fresh water and marine deposits are strikingly expressed in their accounts of the origin of the Portland *dirt-bed.* Dr. Buckland and De la Beche inform us, that it lies between fresh and salt water deposits, is from twelve to eighteen inches thick, and of a dark brown colour, containing many silicified trunks of coniferous trees, and the remains of plants of the zamia and cycas families.

Professor Henslow asserts, that root-shaped cavities descend from the bottom of the *dirt-bed* into the subjacent Portland stone; whence he infers, that "the uppermost beds of this stratum, though now solid, were soft when the trees grew." Who can imagine, with Mr. Henslow, that a stratum deposited from water, and subsequently covered with soil in which forest-trees could grow, would continue soft for so long a period, and finally be hardened into stone? Those, however, who coincide in the following hypothesis of Lyell, will feel no difficulty in crediting the opinion of Henslow; that " the beds of oolite which are full of marine shells became dry land, and were covered by a forest; that the climate was such as to admit the growth of the zamia and the cycas; that the land sank down, and was submerged with its forests beneath a body of fresh water; and that the uniform preservation of this thin bed of black earth over a distance of many miles, shows the change was not attended by any violent rush of water. But in sections of more complicated appearances, where beds of carboniferous clay imply other oscillations in the level of the ground, it is inferred, that the same ground underwent more than once very singular changes: first, the sea, in which the corals and shells of the oolite grew, occupied a great part of the south of England; then land, which supported a vegetable soil with cycadeæ; then a lake, in which fresh-water strata were deposited; then, again, land, on which other cycadeæ and a forest of dicotyledonous trees flourished; then a second submergence under fresh water, in which the wealden-strata were formed; and finally, in the cretaceous period, a return over the same space of the ocean."*

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* Geology, vol. iii, p. 376.

If one spot of land can be thus raised and submerged a hundred times over to answer the purpose of geologists, while the country around remains unaltered, the ridicule of Voltaire may as justly be applied to the theory of the wealden-formation, as to the cosmogony of Burnet or of Whiston.

The existence of these alternate layers of strata in various localities, and especially in the mountainous regions of the earth, is adduced by geologists in proof of the ages of strata, and of the indefinite length of time necessary to form the stratified series of rocks by depositions from water. Were the oolite and wealden beds of England, and the numerous strata of geological epochs, formed by successive depositions from fresh and salt water, there could be no doubt of the great length of time necessary for such operations; but geologists erred in their premises; consequently, their conclusions are invalid.

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* Geology, vol. iv, p. 358.

The stratification of mountains, and the marine remains which are found at great elevations, are adduced as proofs that these were once the bottoms of ancient seas, and were subsequently raised to their present positions by some of those extraordinary revolutions, to which geologists suppose this planet had been subject. The position of the strata through which the mountain-mass appears to have been thrust up, is supposed to confirm this notion.

But these facts afford no conclusive evidence in favour of geological opinions, as they can be accounted for by other means. If a heterogeneous mass of loose matter be stratified with water which gradually passes through it, a new arrangement will take place, and stratification, in many instances, will be the result. This effect is strikingly exhibited in sections of large sand-hills in the vicinity of Cork. Several layers of pebbles, coarse gravel, and very fine sand, alternate with each other, and exhibit all the appearance of stratification. Had these hills once formed the bottoms of lakes, or the beds of rivers; or had these layers been depositions from water in any way that we can conceive, the pebbles and coarse gravel should occupy the lowest positions. But such is not the case. Beds of the coarsest kind are incumbent on others composed of the finest particles; and generally, beds of the finest sand are found at the greatest depths to which the pits are worked. How has this occurred? We presume in the following manner: these hills were formed either by the Noachian deluge, or when, on the third day, the dry land was raised above the ocean by the Almighty Creator, whether by natural or supernatural means we will not now investigate. The rain-water, which for ages percolated through these hills, carried with it, in its descent, the finer particles of matter, which, accumulating at certain depths, formed the existing strata of fine sand. The coarser particles which were left behind, having greater space, fell together and formed the gravel and pebble beds. The layers of fine sand occurring at certain intervals, with beds of a coarser kind always incumbent, demonstrate the truth of this hypothesis. The large pebbles sometimes found in the fine sand, prove that an accumulation of fine particles took place without displacing the preoccupying matter; and thus may several layers of strata be accounted for, both in mountain-masses and in lower levels, without having recourse to the immense lapse of ages which geologists deem necessary for the formation of the stratified masses, occurring in mountain-chains.

All the works of God are perfect, and evident design is displayed in every part of the visible creation. Each individual object is fitted to the end for which it was designed; nor can the utmost stretch of man's ingenuity suggest any improvement. This perfect adaptation of objects to the end of their creation is strikingly manifest in the organic kingdoms; it is equally the fact, not only in the mineral world, but in the arrangement of strata; not only in the composition and distribution of matter, but in the actual position wherein it is placed.

The formation of the earth's surface has been no more the effect of chance, than the natural causes by which it is watered, and by which life and fertility are diffused throughout the land. All countries slope towards the sea, to carry off the superfluous water, which otherwise would inundate the land, and prove fatal to animal and vegetable life. Mountains were as necessary to give rivers their direction, and furnish the necessary supplies of water, as fertile plains and valleys to produce the vegetables required for the maintenance of animal life.

The strata of mountains are different from those of the surrounding low lands. It would be as unnatural to find the strata of the plain ascend the mountain-flank and crown its summit, as to expect that oaks and elms should occupy the place of the mosses and lichens of snow-capped regions; or that the African camel and rein-deer of Lapland could inhabit the same tracts and partake of the same fare.

Geological theories must remain imperfect so long as geologists admit no fixed state, in which to recognise matter in coming from the hands of the Creator. We know of no existing form of stratum which they suppose not to have passed through a variety of natural operations previous to its assuming that form: boulders, pebbles, sands, &c., must, they say, have been for long periods exposed to the effects of running water, to be so rounded. Rocks must have been indurated from matter which had pre-existed in a different state, as clay, sand, sediment, &c. Clays and soils, they assert, must have been produced from the worn-down materials of rocks. Earthquakes must have been the agents in fissuring strata. Insects must have produced limestone, chalk, silica, &c., and these substances must be supposed to have existed in some other form, as they partly supply nutriment to plants and animals. In fact, no state is recognised as that in which matter first appeared, and yet, without determining this most important point, every system devised to account for the present condition of matter, must be vague, unsatisfactory, and objectionable.

Whoever, therefore, admits an overruling Providence, and the interposition of creative Power in the production of matter, must also admit, as the most rational hypothesis, even though Scripture were silent on the subject, that as the originals of all plants and animals were created at first, so were also the originals of all existing orders of minerals, by the Almighty, and then subjected to all those changes and modifications of form and property, which natural causes can produce. The disintegration of minerals by the elements, and their reconsolidation, would produce such varieties in the mineral world as the animal and vegetable kingdoms display. The new solids thus formed, would, in some cases, be similar to the originals; in other cases, somewhat different from them. "The separate parts of disintegrated granite," says Lyell, "are bound together again by silex, so that the granite seems regenerated in a new and even more solid form." Several rocks have thus been formed, in which organic remains, or even other minerals, might have been introduced, and this simple but rational hypothesis would be in strict harmony with all the laws by which such natural operations are regulated.

CHAPTER IX.

First appearance of carbon—Origin of limestone—Carbonic acid—Carbonate of lime—Opinions of De la Beche and Dr. Buckland—Lime in primary rocks—Limestone of Guadaloupe—Food of animals,—its effects—Scale of creation—Cretaceous fishes—Iron—Prints of human feet in secondary limestone—Chalk in Europe—Origin of chalk—Fossils in chalk—Chalk-formations—Chalk of Northern and Southern Europe—Impure chalk, how produced—Animalcula—Marine animalcula—Quantity of lime in water—Act of creation—Absence of chalk in United States—Coral-reefs—Coral-islands—Limestone of the Rhine—Chalk, greensand, and gault—Geological speculations.

According to the geological epochs of rock-formation, carbon makes its first appearance in primitive limestone;* a circumstance which has led some writers to imagine that these rocks "owe their origin to some early and obscure stage of organic existence on the surface of the earth;" and to confirm this opinion, several species of limestone, composed almost entirely of animal remains, are particularly alluded to, as illustrative of this idea.

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* Hence, no carbon can be supposed to exist in those rocks which geologists deem of earlier date than primitive limestone; yet, carbonic acid gas is evolved from springs which rise through granite near Clermont, as well as in the tertiary limestone of Limagne. Whence came the carbon? Can it be that coal or calcareous rock lies *underneath* the granite?

"In central France," observes Lyell, "a district where the primary rocks are *unusually destitute of limestone*, springs, copiously charged with carbonate of lime, rise up through the granite and gneiss; one of these springs, at the northern base of the hill upon which Clermont is built, issues from volcanic peperino, which rests on granite.

This is one of the many cases in which the extended inductions of geologists have betrayed them into errors. It is true, that several species of limestone exist, which, from the multiplicity of shells and other organic remains they contain, show that they have been derived, at least in part, from the animal world; but it is not only untrue, but absolutely impossible, that all limestone could have its origin either from the animal or vegetable world, or from the union of both.

How could limestone be formed from organic bodies, when the identical substances require lime as one of their constituents? Lime is as necessary for plants and animals, as carbon is for limestone. Organic bodies are not produced without lime, and consequently, limestone could not require the carbon of organic bodies to form it. Limestone was at first produced by that creative Power which needs neither animal nor vegetable matter to form it; nor the aid of primitive limestone, when the work of the third day's creation started into existence. "He spoke, and they were made: He commanded, and they were created."

Mr. Chambers says, that, with respect to the deposition of the oolite group, nothing very satisfactory can be said. Whence came the immense quantity of carbonate of lime, is a question not easily solved. To account for it by springs, similar in size and saline contents to those we now see, appears to be unphilosophical. Many limestones are nearly altogether composed of organic remains; and this has led to a theory, that these animals extracted lime from the water, leaving their shells, through millions of generations, to be gradually converted into limestone. Notwithstanding all that we can suppose to be deposited from springs and organic bodies, " there remains," says

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Another incrusting spring in the same department, rises in a gneiss country, at the foot of a regular volcanic cone, at least *twenty miles* from any calcareous rocks."—Geology, b. ii, p. 308. Whence came the carbonate of lime? Does lime underlie the gneiss? or do these springs penetrate the earth's crust from the nearest limestone district?

De la Beche, " a mass of limestone to be accounted for, distributed generally over a very large surface, which requires a very general production, or rather deposit, of carbonate of lime contemporaneously, or nearly so, over a great area."* De la Beche is of opinion that there is a great mass of limestone to be accounted for. We coincide with him on that point, and believe it can only be accounted for by the act of creation.

" It is a difficult problem," observes Dr. Buckland, " to account for the source of the enormous masses of carbonate of lime that compose nearly one-eighth of the superficial crust of the globe. Some have referred it entirely to the secretion of marine animals; an origin to which we must obviously assign those portions of calcareous strata, which are composed of comminuted shells and corallines; but, until it can be shown, that these animals have the power of forming lime from the elements, we must suppose that they derive it from the sea, either directly, or through the medium of its plants. In either case, it remains to find the source whence the sea obtained, not only those supplies of carbonate of lime, for its animal inhabitants, but also, the still larger quantities of the same substance, which have been precipitated in the form of calcareous strata. We cannot suppose it to have resulted, like sands and clays, from the mechanical detritus of rocks of the granitic series, because the quantity of lime these rocks contain, bears no proportion to its large amount among the derivative rocks. The only remaining hypothesis seems to be, that lime was continually introduced into lakes and seas, by water that had percolated rocks through which calcareous earth was disseminated."†

Dr. Buckland here admits, that primary rocks of the granitic series contain lime. If they contain lime, they must contain carbon, a conclusion at variance with the opinion of other geologists, who affirm that carbon makes its first appearance in primitive limestone. If granitic rocks contain lime, then lime must have existed before animals or vegetables were created, even according to geological theories. How inconsistent, then, to infer, that because *some* limestones contain organic remains, *all* limestones must have been derived from the animal kingdom; and from such data to deduce the great antiquity of our planet, and the indefinite ages necessary to form such strata, though geologists themselves affirm, that the huge masses of limestone in Guadaloupe, were formed in a few years—since 1710!

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* Geology, p. 27.

† Buckland's Geology, vol. i.

It is almost needless to remark, that fishes could not form lime, were it not in the food which they consume. Animals must derive from food, and vegetables from the soil or atmosphere, those substances necessary for forming and preserving their various parts.

Land-animals consume plants of the azote family, to acquire and preserve muscular strength; saccharine plants supply the decay of the lungs; and they fatten upon oily plants. Fishes, too, must be supplied with that species of food necessary for enabling them to fulfil the ends of their creation. They could not form shells, if nature had not supplied them with the materials of which these shells are constituted, and, consequently, such materials have not been derived from the animal kingdom.

Phillips says, that "it is not meant to affirm that the materials of which these rocks consist, have not existed together in any other combination, or been subject to other conditions previously." Here, again, the inconsistencies of geological theories appear. For if, in the scale of creation, geologists will have the less perfect beings always to precede those of a higher order, as if to prepare the earth for the reception of beings with a more perfect organization; why should it be deemed necessary to invert this order for the sole purpose of producing limestone? Ferns, lichens, polypi, &c., were produced, as some geologists affirm, to prepare the earth for beings of a higher order; carbon, silica, alumina, &c., as if to supply materials for the diamond, the zircon, the hyacinth, and the other families of precious stones; but to produce limestone, forsooth, a series of organic beings were necessary!

But should it be said, that though limestone owes its existence to these creatures, yet they were not expressly created for that purpose. Either they were created for that identical object, or there would have been no limestone in the universe if these testaceous fishes had not been created. In this case, all other animals, and vegetables too, would have been deprived of this useful mineral, which enters so largely into the composition of almost every being in the organic kingdoms. The obvious consequence, therefore, is, that either limestone is not the production of madrepores and other testaceous fishes, or that these have been created for the express purpose of producing limestone. In the latter case, a vast proportion of all known rocks, and a mineral so necessary for the existence of animals and vegetables, was itself the production of animals from some previously-existing substance; a conclusion at once as absurd as it is ridiculous. Iron is found in blood; are we thence to conclude that no iron existed until the blood of animals supplied the materials which composed it? One conclusion is as rational as the other.

What will the advocates of this theory say, when they learn, that "the prints of human feet have been found in naked limestone of the older secondary rocks"?* Either human beings existed in the geological epochs of this formation, or these rocks were consolidated since man was created. Which alternative will geologists adopt? And, as a further proof that no such imaginary eras have existed, Mr. M'Lure assures us, that "some shells of recent alluvial formations are identical with species found in secondary rocks."

As chalk and lime are composed of the same substances, geologists imagine their theories of limestone-formations are corroborated by the recent observations made on chalk.

In Europe, this mineral extends from the north of Ireland, in a south-easterly direction, to the Crimea, 1140 geographical miles, and from Sweden to the south of Bordeaux, 840 miles. The vast accumulations that exist in England, France, Germany, Poland, Sweden, Russia, and along both sides of the Mediterranean, and the opinion now rapidly gaining ground, that all this chalk is composed almost entirely of animalcula of the infusoria kind, furnish geologists with arguments in proof of the "immense lapse of ages" necessary for the production of this mineral. Could this hypothesis be well sustained, there could be no doubt of the great length of time required to produce such a formation. Dr. Ehrenberg of Berlin, and many other eminent modern geologists are zealous advocates of this opinion, though Lyell supposes chalk "to have originated in the sea in the form of sediment, and to have been subsequently elevated above the waters, and exposed to the effects of the elements." M. De la Beche says, that "the lower portions of this group graduate into the chalky or higher portions;" and from this circumstance, seems rather disposed to favour the theory of its being a deposit from a chemical solution of carbonate of lime and silex; but does not think that springs, or any set of springs, could have produced the great deposits of chalk, unless, perhaps, we may look to a greater exertion of the power which now produces the thermal waters, for a possible explanation of the observed phenomenon.

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* Chambers, on the United States, vol. i.

These differences of opinion should, at least, deter young geologists from hastily adopting theories founded on insufficient data; and such we esteem the opinion of Dr. Ehrenberg; for, though the microscope may reveal minute shells of infusoria, and though other fossil-shells may be visible, and even abundant, in some species of white chalk, and although fragments of corals and sponges are discovered in this mineral, still, there are many reasons for believing that no hypothesis, save that of creation, can satisfactorily account for its present condition. Chalk is composed of the same materials as limestone and marble, and, evidently, owes its origin to the same cause. Changes and modifications have, doubtless, taken place, but not to a greater extent than natural operations would lead us to anticipate.

Several minerals have been decomposed and disintegrated, and the materials, so separated, have again been reconsolidated. New rocks have been reconstructed, similar to the pre-existing ones. New combinations have been formed, and these operations are of ordinary occurrence; but to infer thence that all rocks have been so produced, is inconclusive.

Chalk, as well as limestone and marble, has existed from the beginning; and in the countless variety of minerals, we only see that self-same evidence of design, so like what is witnessed in the zoological and botanical divisions of the creation.

If the worn-down materials of a chalky district were collected into a lake of fresh or salt water, the mud of this lake would contain such organic remains, as portions of the chalk-formation now exhibit. In the island of Bermuda, there are many basins surrounded by coral-reefs, at the bottoms of which a soft, white mud is formed by the decomposition of the corallines. This mud, when dried, cannot be distinguished from common white chalk. If chalk so formed contains organic remains, are we to conclude that all chalk should contain them? But the lagoons of Bermuda are not the only examples of this kind: similar instances abound in many of the South-Sea islands.

If, in such formations, the skeletons of land-animals were found, it should be a matter of no surprise, as such are actually found in the yellowish limestone of Denmark, and in similar rocks at Maestricht, both of which formations are intimately connected with chalk. In the Maestricht limestone the remains of large reptiles are found, but this does not warrant the general conclusion, that *all* chalk or limestone must contain such remains; or, that both must have been formed in a similar manner.

The wide difference between the chalks of the north and south of Europe rather leads to the conclusion that all have not been produced by animal labour or from animal remains.

Mr. Darwin is of opinion that "much of the white mud, found at the bottom of the sea, near coral-reefs, has passed through the bodies of worms, by which the stony masses of coral are everywhere bored; and other portions through the intestines of fish, as, on opening the bodies of certain gregarious fish of the genus sparus. he found them full of impure chalk." Dr. Buckland asserts that "remains found in chalk, which were deemed the cones of the larch, were, in reality, the excrements of fish."

As some birds eat chalk very greedily during the breeding season, and as worms and fishes do so too, as the above examples prove; it is no extravagant hypothesis to suppose that animalcula may also, at least in part, subsist on chalk, or on some other substances connected with this mineral.

There are few, perhaps not any, material objects in which microscopes of high magnifying power will not discover animalcula. The grain of sand which the naked eye cannot discover, is frequently found to be the abode of one or more of these minute creatures. No plant, no leaf of the vegetable world is without an occupant, and yet no single being of the animal or vegetable kingdom comes into existence without a parent.*

As we perceive, at certain seasons, multitudes of insects of the same colour as the vegetables on which they feed, and as we are assured that every part of the mineral world teems with life, it is nowise visionary to suppose that beds of chalk have had their tenants too, especially such as might have been at any former period covered by the sea, or by a lake of fresh or salt water. The slab in our harbours teems with animalcula; and it is certain, that wherever chalk has been produced, as in Bermuda, or the islands of the Pacific, it *must* exhibit organic remains in great abundance. Remains of animalcula may be expected not only in chalk, but in any strata over which the ocean flowed for any length of time, even during the period of the Noachian deluge; for marine animalcula are so numerous as to set all calculation at defiance. The sea, for tens of thousands of square miles, is changed from a blue to a green, a red, or a yellow colour, by inconceivable multitudes of microscopic animals, principally minute sea-blubber, *medusæ* and *infusoria.* Cook, Colnet, Scoresby, and several other eminent navigators, bear testimony to the countless myriads of animalcula which discolour extensive tracts of the ocean, in various parts of the world. Now, it is evident that these may be present wherever sea-water can penetrate the earth's crust; and they have been present wherever salt-lakes were formed by the deluge, or by any other overflowings of the ocean; and as these creatures multiply beyond conception, and also perish very rapidly, it is quite natural to find their shells and skeletons in districts where chalk, lime, or silica abounds.

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* The absurd notion, that new species of animalcula may be produced at will from animal or vegetable substances by fermentation, infusion, decoction, &c., is entertained by some modern philosophers.

Almost all water is impregnated with lime, or holds it in solution. Dr. Marcet estimated the amount of muriate of lime in the waters of the Atlantic, at about the one five-hundredth part of their weight; and as insects are known to form coral, may not insects of a different species form chalk, or lime, or silica, in localities where these substances had previously existed? that is, by extracting from the waters of the sea, those substances which, when moulded in the stomachs or intestines of these animalcula, may form a species of chalk, or lime, or of silica. We say a species of chalk, or lime, or of silica; for, though the elaborated substances may resemble these minerals, and actually exhibit all their properties, yet they may be different from the originals whence they have been derived. Insects may be the principal agents in altering or modifying certain properties in matter; but without the preexisting substances, it is absurd to think that such could have been formed by animalcula. It is, therefore, beyond doubt, that all these substances exist independently of animal or vegetable aid, and that whatever may have been the discoveries of Ehrenberg, or any other philosopher, in chalk, tending to prove its origin from the animal creation, such discoveries, if at all worth notice, must have been made on particular species of chalk, and cannot, therefore, be extended to the whole formation.

"We see no reason," says Lyell, "for supposing that lime may not have existed, as well as any other mineral substance, before the first organic beings were created, if it be assumed, that the arrangement of the inorganic material of our planet preceded, in the order of time, the introduction of the first organic inhabitants." But as Scripture concurs with the natural order of events to prove the antecedence of the inorganic kingdom, we see no reason why chalk and silica, as well as lime, may not have existed before organic beings.

But granting that these substances existed previously to organic beings, whence were they originally derived? The act of creation supplies the only rational answer to the query, and as recourse must be had to this solution, what advantage can geologists derive from the supposition that this took place a hundred millions, or even a thousand millions of years back? Length of time alters not the creative act: an eternity would have preceded it in that case, as well as if creation took place but a thousand or six thousand years ago. Geology, as a science, has nothing to gain by the antiquity of the earth.

The facts already noticed show evidently, that chalk-formations, containing animal-remains, may exist without affording any proofs that chalk derived its origin from animals; and this conclusion is confirmed by the fact, that "no chalk, nor roestone, nor oolite exists in the United States, though the localities where these might be expected are sufficiently marked"* by all those external signs by which geological science would lead us to find these minerals.

Why, then, are these minerals wanting in the United States? Is it because there were no insects to form them? or, because the locality was unfavourable? No; it is simply because they were not created there.

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* Information for the People, 'United States.'

To show that chalk might have been the work of insects, and might, consequently, have occupied an immense length of time in its formation, the coral-reefs of the South Seas are cited as analogous productions. The following remarks of Lyell will, however, prove that no such inference can be justly drawn, even though we grant that both formations were analogously produced. "The calcareous matters termed coral-reefs, are by no means exclusively the work of zoophytes; a great variety of shells, and among them some of the largest and heaviest of known species, contribute to augment the mass. In the South Pacific great beds of oysters, mussels, and other shells, cover in profusion almost every reef, and in the beach of coral-islands are seen the shells of echini and broken fragments of crustaceous animals: masses of very compact limestone, such as could only be produced by precipitation, are also found, even in the uppermost and newest parts of the reefs. The coral-islands may be but a chain of submarine mountains, crested by coral-formations."*

MM. Quoy and Gaimard are of opinion, that the species which contribute most actively to the formation of solid masses of coral, do not grow where the water is deeper than twenty-five or thirty feet; others think they may commence at a depth of ninety feet. Under these circumstances, and considering the multitude of labourers, there is no necessity for supposing myriads or millions of years for the formation of these coral-reefs, when a few hundreds may suffice, notwithstanding the slow growth of coral.

The circular or oval forms of the coral-islands of the Pacific, with lagoons in their centres, naturally suggest the idea that they are nothing more than the crests of submarine volcanoes, having the ruins of the craters overgrown with coral; and this is rendered still more probable, as the coral-banks of the Red Sea are not of a round, but square form, which shows the zoophytes do not build circular islets with a central cup-shaped cavity.

How frequently are simple facts, for which we cannot at first account, magnified into difficulties, and the most extravagant theories devised to explain them, which, subsequently, a single fact overturns. Rocks of great extent appear to have been composed of the shells and remains of animalcula. The limestone on the left banks of the Rhine appears to be a mass of fossil-snail-shells. This phenomenon, however, is explicable on natural grounds, when we consider that the small deltas of the torrents which enter the Swiss lakes, are strewed thickly with innumerable shells, brought down from the valleys in the Alps during the melting of the snows in the preceding spring. So the sands and mud on the borders of the Rhine are covered with shells, which have multiplied in the lakes, stagnant pools, marshes, &c., and which may have formed those rocks in a few centuries. Some geologists may imagine these to have been formed at periods of time "incalculably remote."

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* Geology, vol. ii, p. 299.

"The inferior white marly chalk," says Lyell, "passes into the upper greensand, this again passes downwards into clay and marl, called *gault*. The greenstone-formation is a mechanical deposit, made up of sand, clay, marl, impure limestone, &c. But we naturally inquire how it could happen, that throughout a large submarine area, there could be formed, first, a set of mechanical strata, such as the greensand, and then, over the same space, a pure zoophytic and shelly limestone, such as the white chalk. Certain causes, which, during the first period, gave rise to deposits of mud, sand, and pebbles, must, consequently, have ceased to act; for it is evident, that no similar sediment disturbed the clear waters of the sea in which the white chalk accumulated. The only hypothesis which seems capable of explaining such changes, is the gradual submergence of land which had been previously exposed to aqueous denudation."*

Here are certain strata, peculiarly arranged, exhibiting marks of mechanical deposition, for which geologists cannot account according to their theories. Lyell is so perplexed as to " where the continent was placed from the ruins of which the wealden-strata were derived, and by the drainage of which, a great river was fed," as to feel himself " half tempted to speculate on the former existence of the Atlantis of Plato;" a speculation, indeed, which says little for geology, and still less for his theory of the wealden-strata.

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* Geology, vol. iv, p. 263.

The act of creation, by which determinate positions were assigned to peculiar forms of matter, and the subsequent vicissitudes to which matter, in all its forms, is ever liable, will account for the appearances of these strata more rationally than the theories of geologists, in which imagination has generally too large a share.

The aqueous denudation of a stratum could, in some cases, be as effectually produced by subterrene currents as by the passage of water over the surface; and deposits of mud, sand, and pebbles could have been formed by water in cavities deep in the bowels of the earth, as well as by seas or rivers. Much of the mechanical arrangement of the greenstone-formation may be thus explained, as satisfactorily as by extraordinary elevations and subsidences, or imaginary revolutions, submergences, &c., if simple explanations, which have nothing but truth and common sense to recommend them, could be relished as well as the fanciful speculations of the learned.

CHAPTER X.

Flints, quartz, &c., in chalk—Silicious rocks—Organic remains in flints—Qualities of bodies—Mineral kingdom—Elementary substances—Fossil-salt—Origin of salt—Countries in which it abounds—Salt of the Mediterranean Sea—Quantity of salt in sea-water—Salt of Poland—Salt-lakes—Salt-mountains—Cheshire brine—Saltness of the sea—Properties of water—Relative extent of land and water—Elevating and depressing causes—Ocean-bed—No general movement of the sea exists—How water affects the earth's crust—Petrifying waters—Petrifactions—Thermal waters—Formation of travertine—Sandstones and conglomerates—Cementing-matter—Mysteries of nature—Organic and inorganic kingdoms—Solidification of fluids—Rotation of elementary substances—Examples—Rocks, soils, strata, &c.—Evidence of design in the visible creation.

THE presence of flints in chalk has hitherto baffled the researches of geologists, in their attempts to account satisfactorily for the existing state of matter, without reference to the act of creation.

"The distance between the layers of flint in chalk," says Dr. Buckland, "must have been regulated by the intervals of precipitation, each new mass forming, at the bottom of the ocean, a bed of pulpy fluid, which did not penetrate the preceding bed on which it rested, because the consolidation of this last was so far advanced as to prevent such intermixture. Nevertheless, the separation of the flint into layers, so distinct from the chalk, is a singular phenomenon, and not yet accounted for."*

But the presence of flints in chalk, and the manner in which the layers are disposed, present not the only difficulty attending these strata. "The occurrence here and there," remarks Lyell, "of pebbles, of quartz, and green-schist, in chalk, some of them two or three inches in diameter, has justly excited much wonder. If these were carried to the spots where we now find them, by waves and currents, how happened it that no sand or mud was transported thither at the same time? We cannot conceive them as drifted by ice, for that would imply a cold climate in the cretaceous period; a supposition inconsistent with the luxuriant growth of large-chambered univalves, numerous corals, and many fish and other fossils of tropical forms."* How frail the theories which such trifles overturn!

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* Geology, vol. i.

Silicious rocks, as well as chalk, are said to exhibit, under the microscope, traces of animal remains; hence, it is inferred by some, that rocks of this character have been formed at the bottom of the ocean by marine animalcula, and subsequently raised by some geological phenomenon, or left exposed by the withdrawal of the sea from the places where the deposits were made. But this theory is as untenable as the geological hypothesis of limestone-formation. The fact that silica exists in some vegetables, demonstrates that this mineral is anterior to the organic kingdoms. The agricultural chemist knows well, that if the soil in which wheat is to be grown wants silica, the corn-stalk cannot come to maturity. How, then, could this mineral be produced from organic bodies?

Flints containing organic remains are said to be frequently found in chalk, and this fact is cited as proof of the recent formation of chalk. Now, it should be remembered, that flints consist principally of silica; that there are vast limestone-masses with silicious bases; that chalk consists principally of lime; and that lime-water and the liquor silicium coming in contact, a precipitate, composed of both earths, ensues. Lime and silica, in equal portions, subjected to heat, unite and form a semitransparent mass, which feebly strikes fire; also, lime, silica, and various other bodies, unite. It is not, therefore, unreasonable to suppose, that where these substances are in contact, and under peculiar circumstances, which are not known at present, otherwise than by the conjectures of geologists, that flints may be rapidly formed, and, consequently, may contain any substances, either organic or inorganic, which may happen to be present during the process of formation.

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* Geology, vol. iii, p. 322.

Such flints as contain organic remains are, evidently, of recent formation; but this does not prove that all flints must have been so produced. Insects may, perhaps, assist in forming flints from chalk, in some way similar to that in which the oak-leaf-galls are formed; or, more appropriately, as polypi form coral. This is no improbable hypothesis. The varieties of coral depend on the forms, magnitudes, and colours "of the animals which produce them. The principal kinds of coral are, red, white, and black; the acori, or blue coral of the African coast, is very rare; there are also varieties of ash and green corals."* We notice these varieties as instances of the extraordinary effects to which matter is subject in passing through the intestines of animals.

We are in total ignorance of the *substance* of bodies:—we can only judge of their external properties. Our senses take cognizance of their colour, form, taste, &c.; but, of their substance we actually know nothing. How very different are the various parts of animal bodies, though all derived from the same aliment! Were we to judge of flesh, blood, bone, hair, feathers, &c., by their distinct properties, we never could imagine all originally combined in animal food. Had we not known the silk-worm, could we think that any natural process would change the mulberry-leaf into that beautiful and useful article, so much prized by man? Who can explain *how* that fluid matter which comes from the silk-worm, in contact with air, could be instantaneously changed into a fine, shining, tenacious substance? If, therefore, animalcula be instrumental in changing chalk into flints, we cannot look upon the change as opposed to the order of nature, or as requiring periods of time incalculably great. We are not to estimate the time by the amount of work, so much as by the multitude of labourers, or the other circumstances by which it may be accompanied.

The mineral kingdom is not exempt from the state of fluctuation to which the other parts of creation are subject. Mechanical and chemical agents concur in disintegrating rocks, and in reconsolidating others. But this rotatory process had a beginning, though geologists will not tell us when or how. The prototypes of all existing things were first produced by creative power. From this source the originals of organic and inorganic bodies derived their being. Varieties are multiplied in the animal and vegetable kingdoms. Species, and, perhaps, families in each, have become extinct. Rocks, too, have been wasted and worn down, and new ones reconstructed from the ruins, similar in some respects, but different in others, from those that preceded them.

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* London Encyclopædia, vol. vi, p. 465.

Organic remains discovered in rocks should create no surprise, as such results may be expected in the natural course of events. The modifying influences of the elements, and the partial effects which they have occasioned, are mere natural consequences, arising from the established order of things ; but to extend these effects to the actual production of the stratified or unstratified series of rocks, as geologists are wont to do, is inconsistent with the laws of nature, opposed to common sense, and to the express word of God.

If some rocks contain organic remains, or exhibit marks of igneous action, there are hundreds of others which geologists refer to the same origin, which contain no fossils, and give no indication of igneous origin. " There are rocks," says Marsilli, " which contain no organic remains," in which such remains may be expected to exist had they been deposits from water. Geologists too often make isolated and particular facts the bases of general theories.

The elementary or simple substances are so few,* compared with the almost infinite number of compound bodies, that we may naturally expect to find a multitude of bodies similar in composition, though of very different origin ; while, on the other hand, we are assured that the most trivial difference in composition, nay, a different arrangement of the same substances, is sufficient to produce the most marked distinctions in external form, as well as in the internal properties. This necessary, this indispensable similarity in the constituent parts of bodies, has led some geologists to imagine that resemblance of constitution denoted identity of origin; and this error in principle has been the source of many unwarranted conclusions.

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* There are about sixty simple substances recognised.

Rocksalt is ranked with the new red sandstone group, and is considered an aqueous rock by some geologists: Lyell, however, remarks of fossil-salt, that the theory which has obtained most favour in latter times attributes salt-mines, or fossil-deposits of this mineral, not to precipitation from an aqueous menstruum, but to sublimation from volcanic exhalations from below. Were this hypothesis true, fossil-salt should not be ranked with the aqueous class of rocks, although the end geologists have in view would be equally well attained, namely, the indefinite ages of the strata which compose the earth's crust.

The existence of this mineral in districts which exhibit little appearance of volcanic action, and on the contrary, the absence of fossil-salt in modern volcanic regions, are facts unfavourable to this hypothesis. The existence of mineral veins are also ascribed by some to sublimation; and as the arguments against this notion are equally applicable in the case of fossil-salt, we will, at present, confine our remarks to salt as a deposit from the ocean.

Salt is found to exist in animal and vegetable bodies; it has been discovered in human blood, and in some cases extracted from the ashes of vegetables, even from the ashes of ferns. May we not, then, with as much reason, say, that salt is derived from organic bodies, as that limestone and chalk are animal productions? And yet no geologist has ventured to assert this. Several affirm it to be a deposit from the ocean. The ocean, it is true, abounds with such vast stores of salt, that had there been none besides in existence, mankind might thence derive a sufficient supply for all their wants. There are few countries which abound not with this useful mineral. England, Poland, Spain, Italy, Germany, &c., contain salt-mines. Near Astracan, in Russia, are two high mountains which consist wholly of salt. There are also mountains of salt in Tunis, Algiers, Cordova, and in several parts of Asia.

The whole island of Ormus, in the Persian Gulf, is one mass of salt. How those vast accumulations could have been formed by sublimation, or by deposits from water, no geologist has attempted to explain. They are far above the ocean level, and how deposits of salt could have been made from the sea, unless from detached portions, by evaporation, we are at a loss to conceive. No one will suppose that any admixture of other matter with the waters of the sea would cause a precipitate of *all* the salt in any given quantity of sea-water; and yet, without some similar process, our present salt-mines could not have been produced from sea-water. Evaporation is the only means by which accumulations of salt are formed, and even this process can take place only in peculiar situations.

The evaporation from the Mediterranean being much greater than the amount of fresh water brought into it by rivers, the deficiency is supposed to be made up by the current from the Atlantic, through the Straits of Gibraltar. This would naturally increase the saltness of the Mediterranean. But the excess above the saltness of the Atlantic not being as great as may be supposed,* the surplus salt is believed to be precipitated to the bottom, where great accumulations may exist. If this be really the case, and were the bottom of this sea laid bare, we may expect vast quantities of salt, not collected into dense masses as in our salt-mines, but scattered over a surface equal to the bed of the sea. In this collection, we may also expect to find vast quantities of organic remains, intermingled with inorganic matter very different from salt. In a word, the appearance of this bed would be altogether different from the fossil-salt-mines of the present period; so that the obvious inference must be, that fossil-salt is not a deposit from water.

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* The quantity of water brought to the Mediterranean by all the rivers which flow into it, is calculated at about one third of the amount carried off by evaporation. The equilibrium is maintained by the current from the Atlantic, which constantly brings in its quota of salt, though the evaporated waters carry no part away; and hence, the waters of the Mediterranean should be more salt than those of the ocean. For a similar reason, the waters of the torrid zone should be more salt than those of the temperate or frigid zones.

Dr. Marcet states, that in 100 parts of the waters of the Atlantic, there are 2·56 of common salt. This is, very nearly, $\frac{1}{39}$ of the entire. Taking this as a fair average for salt-water in general, we will have in 39 lbs. of sea-water, 1 lb. of salt. But as the specific gravity of salt is 2130, and of salt-water 1030, hence, about 80 feet of sea-water would be necessary to form a deposit of salt one foot in thickness; and to form a deposit of 100 yards in thickness, (and there are many beds of fossil-salt which exceed this), would require a depth of water exceeding four miles and a half. A sea of this depth should deposit all its salt, or be entirely evaporated, to produce a stratum of salt 100 yards in thickness. Hence, the deepest part of the ocean would not suffice to form the mass of fossil-salt in the mines of Wieliczka, near Cracow, where the mines are already worked to the depth of 743 feet.

Even granting that a deep sea could contain such a quantity of salt, how can we imagine such a body of water collected over Poland and separated from the ocean? Were it connected with the ocean, it could not be evaporated, as the place occupied by the part carried off in steam would be constantly supplied, as in the Mediterranean. If we suppose these vast accumulations of fossil-salt to have been made by deep salt-lakes, it must be noticed in reply, that there are, perhaps, no countries in the temperate zones, (with the exception of the narrow belts near the tropics, called *rainless regions**), in which the average amount of rain does not exceed the evaporation. In Ireland, the evaporation is estimated at about two-thirds of the rain which falls.† In such countries a deep salt-lake would never be evaporated in the ordinary way; and to imagine fossil-salt to be composed of a series of successive deposits, is quite out of the question, as we cannot suppose that a new lake succeeded, as soon as a former one had passed away. If we admit an interval between the formation of succeeding lakes or estuaries, we should also expect a corresponding stratum of matter between the layers of salt, which is nowhere to be found; and hence we infer, that no such changes have occurred.

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* See Geography of the Christian Brothers, 4th Ed. p. 303.

† Industrial Resources of Ireland, by Sir R. Kane.

The difficulty is still increased, nay, rendered almost insurmountable, in the application of the principle to the formation of the island of Ormus, or the salt-mountains of Cordova* or of Astracan. But the objections to the hypothesis do not terminate here. "The great disproportion of quantity shown by analysis to exist between the earthy salts contained in the brine of Cheshire, and those held in solution by sea-water; the ratio here being as one to ten; or the proportion which the earthy salts bear to the pure muriate of soda in sea-water, is ten times greater than that which prevails in the Cheshire brine. The ascertaining of this fact proves, it is supposed, that the rock-salt, the solution of which forms the brine, is combined with a much smaller proportion of earthy salts than exists in sea-water; a circumstance hard to be accounted for on the supposition that the beds of this substance were formed by the evaporation of the sea-water, occupying the valleys and lowest parts of the land."†

Another proof is deduced from the fact, that no marine exuviæ have ever been discovered in these strata, a circumstance which could scarcely have been so, had the land been covered with sea-water for a length of time sufficient for the formation of such beds of salt as do actually exist in so many countries of the Old and New World.

The countries in which fossil-salt is found are not such in external appearance as to lead us to suppose, that if the beds were marine deposits, they would have been confined to the limits they now occupy. Why does not the salt-bed extend over the space, which the ocean supposed to have formed it, must naturally have covered? Why are there not salt-beds in localities where salt-lakes were probably formed by the deluge, and where evident traces of marine deposits are known to exist, at present?

These considerations lead to the conclusion, that fossil-salt is not a deposit from water. Whether the sea was originally salt, or whether its saline property has been communicated by the particles of salt transported thither by rivers, are questions which have long engaged the attention of the learned, but to which no satisfactory solution has been given. The former, in our opinion, is the more rational, even upon philosophical grounds; for rivers could not have carried to the ocean the vast amount of salt which it contains. Besides, we know, that lakes into which rivers have flowed for ages, have not, in all that time, acquired the slightest degree of saltness.*

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* The mountain near Cordova is 500 feet high and 3 miles in circuit.

† London Encyclopædia, vol. xix, p. 256.

If, then, fossil-salt is not a deposit from water, it should not be ranked with aqueous rocks; neither should it be numbered with this class, if it has been produced by sublimation. Geologists, therefore, err in classing it with stratified formations. Neither can they rank it with the unstratified series; for then it should be numbered with the primary rocks, and assigning such a place to fossil-salt, would subject geological theories to a variety of unanswerable objections.

Though it is impossible to deny the many wonderful effects produced in strata by water, still, we cannot ascribe to this element the origin of stratified formations. The abrasion and denudation of rocks by water; the disintegration of others by its expansive and contractile powers; its capability of holding in suspension, and in solution, portions of almost all known substances; its general diffusion over so much of the earth's surface; and the extent to which it penetrates all those formations with which man is acquainted;—all these bear ample testimony to its influence in modifying every form of stratification.

But, unfortunately for the science of geology, the influence of this element is extended far beyond its just limits by modern theorists. They ascribe to it not only the origin of all stratified rocks, but the destruction of former continents, of which they suppose the present ones to be the ruins. The subversion of existing lands, and of all that are to follow in their imaginary category of successive worlds, is to be effected by this element!

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* Were the beds of all existing rivers composed of salt, the quantity would not be sufficient to give the ocean its present degree of saltness.

Were the extent of land and water to depend on the accidental effects of fire and water, in their elevating and degrading operations, how inapplicable would be the poet's words, and how untrue, as regards geology!—

> "Order is Heaven's first law."

Had the extent of the ocean been much greater or much less than it is now, the quantity of vapour raised from its surface by the action of the sun, would not be suited to the exigencies of the animal and vegetable kingdoms. Indeed, the present amount of land and water furnishes the most striking proof of design, rather than the accidental effects of those causes to which geologists would refer them.

The same All-ruling Providence which first produced land and water, still continues, and will ever continue, to preserve unaltered, the necessary amount of both, notwithstanding the partial alterations produced by those elevating and degrading causes, which are in constant operation, though their effects are only discernible in some localities.

Lyell admits that the quantity and elevation of land above the sea may for ever remain the same, in spite of the action of the aqueous causes, which are counteracted by igneous action and other causes; but, while he admits that the quantity and elevation may remain the same, he asserts the constant state of fluctuation to which the continents, as well as the sea-coasts, are liable, and looks forward to the period when no vestige of existing continents will remain.

If the sea, in wearing down the present land, and volcanoes, in forming islands, and elevating portions of submerged strata, were to be the agents in preserving the balance of power between land and water, it is evident the equilibrium would not be preserved. It could not be expected that such opposite causes would produce equal effects; that agents so different would operate results so like. Even the doctrine of chance would not warrant this conclusion, and the final result would be, either the destruction of all lands, or the contraction of the ocean-bed, with the consequent effects upon animal and vegetable life.

The ocean occupies deep and extensive basins, in which it is, as it were, fixed; and though tides, and waves, and currents, agitate its surface, the great body of water in any of the oceans, has no general tendency to shift its place or alter its position. Waves or oceanic currents may wear away a coast, or waste an island, or destroy an isthmus; but they never can affect the vast bases upon which the continents and great islands rest. The present lands form but the summits of immense elevations, which gradually rise from the deepest seas, from the lowest levels of the ocean-bed, to the positions they now occupy; and nothing short of a general movement of the whole ocean could possibly affect them; and we doubt, if even this would be quite sufficient. No such general movement exists; and, if it did exist, it could not effect what geologists imagine.

Even the diurnal motion of the earth produces no tendency, in the waters of the sea, to move in an easterly or westerly direction; nor does it affect the atmosphere so as to give the whole mass a general motion in any direction. Winds in the atmosphere, and currents in the ocean, are produced by causes which do not affect the general masses of water or air upon which they act. Hence, no cause exists by which the foundations of existing lands could be removed; and unless those vast eminences were destroyed, no new continents could be formed. Were existing lands gradually submerged, and the dominion of the sea again established over the surface of the earth, the present amount of matter above the ocean-level, would not fill up the basin of the Pacific Ocean; and we would hope in vain for new continents from the action of earthquakes or volcanoes.

The present continents are the only ones that have existed; and all the effects of elevating and degrading causes on the summits or slopes of those immoveable and immense plateaus, have operated only what the arm of Omnipotence could perform, and what no physical power can remove. The traces of marine remains which existing lands exhibit, will be fully accounted for hereafter; we will, at present, confine our remarks to the effects which water actually does produce on different substances.

The waters of some localities possess petrifying qualities, by which vegetables are converted into stone. It is well known that many lakes hold silica, and sometimes other substances, in solution, and possess, thereby, very peculiar properties. In a lake near Smyrna, the olives from the adjacent trees are petrified. We have seen some of these olives completely converted into stone. Petrifactions are common about Sligo, and some say in the neighbourhood of Lough-Neagh; though Lyell denies this property to the waters of this famous lake. The Sena, and several other rivulets, which feed the Esla, have the property of lapidifying wood and herbs. "In the Azores," says Lyell, "the hot springs of the *Vallas das Furmas*, in the island of St. Michael, possess petrifying qualities. Wherever the water has flowed, the herbage and leaves, more or less incrusted with silex, are said to exhibit all the successive steps of petrifaction, from a soft state to a complete conversion into stone. In some cases, alumina, which is likewise deposited from the hot waters, is the mineralizing material. Branches of the same ferns which now flourish in the island, are completely petrified. Fragments of wood, and an entire bed, from three to five feet deep, composed of reeds now common in the island, have become completely mineralized."* He adds, "Some phenomena seem to imply that the mineralization must proceed with considerable rapidity, for stems of a soft and succulent character, and of a most perishable nature, are preserved in flint; and there are instances of the silification of the young leaves of a palm-tree, when just about to shoot forth."† These are positive proofs of the formation of rocks long subsequent to the creation of existing plants, and presumptive proofs that there have been no successive creations of organic beings; for the sudden formation of flints, shows that rocks, in peculiar cases, may be speedily formed, and hence, that the existence of such formations by no means proves the necessity of indefinite ages for their production, or of distinct creations to supply them with organic remains.

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* Geology, vol. i, p. 323.

† Geology, p. 89.

"It is scarcely possible," says M. Bendant, "to dig into any of the pumiceous deposits of the Hungarian mountains, without meeting with opalized wood, and sometimes entire silicified trunks of trees of great size and weight." The fossil-trees in the Portland dirt-bed, and those of the coal-formation, to which we will hereafter direct particular attention, furnish numerous examples of the lapidifying effects of water. There are also many other ways in which it operates on strata, though we can only notice a few.

It is well known that spring-water, or water continually penetrating the earth's crust, is rarely free from admixtures of iron, carbonate of lime, silica, or some other earthy or alkaline ingredient. Thermal springs rise through all sorts of rocks, as granite, gneiss, limestone, lava, &c., and are impregnated with almost all known substances, chiefly carbonate of lime, iron, salt, silica, carbonic and sulphuric acids, magnesia, mineral pitch, naphtha, asphaltum, &c. The matter thus held in solution or suspension does actually cement sands, indurate clay, form conglomerates, and affect strata in various other ways. Lyell observes, that "sandstones and other rocks in the sedimentary strata of ancient lakes and seas, are bound together or coloured by iron." Rain-water, and springs that hold carbonic acid in solution, are capable of dissolving calcareous rocks; and thus, not only the matter for the earthy secretions of testacea, and for the growth of certain plants on which they feed, may be supplied, but also a sufficient quantity for the cementing of sands and forming strata, to an extent which is not easily conceived.

Several instances of the rapid precipitation of carbonate of lime from thermal springs, and the formation of extensive beds of travertine are known. In the hill of San Vignone, in Tuscany, so rapid is the deposition near the source of the stream, that half a foot of solid travertine is formed every year; and this water, which falls into a pond, is known to have made a deposit of solid rock, thirty feet thick, in twenty years; but a much greater quantity of the matter which constitutes these formations, is carried to the sea. A hard stratum of stone, about a foot in thickness, is obtained from the waters of San Filippo in four months; and a hot spring near Civita-Vecchia, deposits a white granular rock, not distinguishable, in hand-specimens, either in grain, colour, or composition, from statuary marble.

Had water, possessing these qualities, passed through strata of sand, gravel, pebbles, &c., they would be speedily converted into solid masses of sandstone or conglomerate rock, which may contain organic remains, or portions of any other matter which may happen to be present during the process of consolidation.

While so many streams of water, charged with almost every form of mineral, flow through the earth's crust, we should not be surprised if new rocks are constantly being formed. A stream of sulphureous water, as white as milk, descends into the sea from the volcanic mountain, Idionne, in Java. The Fiume Salso, in Sicily, enters the sea so charged with various salts, that thirsty cattle refuse to drink it. The Puianibio, or Vinegar-river, of Columbia, is strongly impregnated with sulphuric and muriatic acids, and with oxide of iron, and countless other streams of water, which permeate the earth's crust, are similarly charged with mineral substances in solution and suspension.

Dr. Buckland says, that thermal springs in volcanic districts issue from the earth so highly charged with carbonate of lime, as to overspread large tracts of country with beds of calcareous tufa or travertine. The waters that flow from the Lago di Tartaro, near Rome, and the springs of San Filippo, on the borders of Tuscany, are well-known examples of this phenomenon.

" In the case of calcareous rocks," observes Lyell, " solidification takes place at the time of deposition ; but there are many deposits in which a cementing process comes long subsequently into operation. When the waters of ferruginous or calcareous springs have flowed through a bed of sand or gravel, the interstices between the grains are filled up, and the whole mass is bound together. In other cases, conglomerates are formed by a silicious cement, and the pebbles are so firmly united, that if a block be fractured, the rent passes as readily through the pebbles as through the cement."

A stranger, travelling through the County Waterford, cannot fail to be struck with the number and variety of the conglomerates which he meets in all directions. The cementing matter, in most cases, appears to be iron. Several streams from the mountains, and along the coast, seem highly charged with solutions of this metal. In many instances, a yellow rust, like that which iron long exposed to damp air exhibits, is seen to descend in vertical streaks from many of those conglomerates ; a fact which evidently shows that the cementing matter is iron.

These numerous cementing substances ; the various properties of water ; its capability of holding and depositing so many different bodies ; the innumerable forms of life which it sustains ; and the mysterious changes in the nature and qualities of matter, which animals are capable of producing ;—these demonstrate our utter incapacity to know or understand the extent of nature's works ; and yet, such is the vanity of man, that every form of matter, every phenomenon, must be explained. We know not, in reality, how a single leaf or blade of grass is formed, and still we pretend to fathom the wondrous works of Omnipotence. We can tell the materials which constitute an animal or vegetable substance ; but, of the mysterious process by which these substances were moulded from the elementary bodies, we are totally ignorant. The soil and atmosphere contain the constituents of vegetables ; the food of animals contains all the substances of which their bodies consist ; but how each distinct part is obtained from the common aliment, is beyond human comprehension. What we admit in the organic kingdoms, we attempt to account for in the mineral world, as if it were more easy to understand the process by which fluids are solidified in organic bodies, than in inorganic compositions. What philosopher can form a just idea of gases in their solid state? We only know them as fluids; we are ignorant of them as solids, although we know they exist as such.

No chemist can form the simplest organic body from the elementary substances, and yet, philosophers pretend to unravel the secrets of nature, and frame theories to explain all existing phenomena. Is it easier to comprehend how carbonic acid unites with the earth or lime, to form limestone, than how it enters into vegetable and animal substances? A forest, thousands of square miles in extent, is formed from mere fluids, in half a century; and, for a mineral formation, not containing the same amount of solid matter, geologists assign a thousand ages. The vegetable world is renewed each season, but to form a stratum of sandstone or chalk, geologists imagine that a million of years can scarce suffice. The mass of osseous matter in the animal creation is formed in a few years, but the nodules of flint found in chalk, must, forsooth, require thousands. The mineral world, like the animal and vegetable worlds, is formed to preserve itself, and the countless ages of geologists are not required for that purpose. The rotatory movements observable in all parts of the creation, extend to inorganic matter also.

The animal body is a machine which renews and repairs itself. Food and rest restore that waste which the functions of life and exercise occasion. The animal creation contributes to supply the vegetable world with carbonic acid, and plants restore again to the atmosphere, the oxygen so necessary for animal existence. Fresh water is supplied to the earth by the action of the sun upon the waters of the sea, and rivers preserve undiminished the quantity of water in the ocean. Herbiferous animals, by their complicated structure, assimilate plants to their own substance, and thus prepare food for the carnivorous, which, though derived from vegetables, is now better fitted to support animals of a less complex structure, and of a constitution incapable of supporting existence by vegetable matter, in its ordinary state. While the waste and decomposition of the carnivorous races give back to the soil and to the atmosphere, precisely the same amount of carbon, nitrogen, phosphates, acids, &c., as the vegetables at first derived from these sources, the same materials are again brought into action, and by a kind of rotation, the elementary substances are made to supply races of plants and animals, and they are, moreover, destined to enter into various combinations in the mineral world.

Rocks, soils, and strata of all kinds, together with each distinct order of mineral, were created by Almighty God in the beginning; and then commenced that system of rotation which the elementary substances have ever since been undergoing. Decay and renovation have marked the mineral world to a certain extent, as well as the other parts of creation. Rocks have been worn down; soils have been renewed; and the waste occasioned by the matter borne down to the ocean, has, in some measure, been restored; but this process had a beginning, and no physical laws require that this beginning should have been at an incalculably remote period. The countless epochs of geologists serve for no other purpose than to perplex timid Christians, to embarrass men of science, and to embolden infidels.

By the chemical affinities of different bodies, by deposits from water, by the action of volcanoes, by the agency of marine animals, and by various other causes, new rocks have been formed, compounded, according to circumstances, more or less than those at first created. These, in their turn, are subjected to the same causes, and may supply the materials which rocks or soils may require hereafter; and thus, by a rotation so common in nature, rocks are worn down, soils renewed, strata formed, but no new matter is created, no old matter annihilated. The elements, though in a constant state of fluctuation, are, nevertheless, subjected to invariable laws, from which no portion is exempt.

Such admirable order is not the effect of mere chance or accident; or the result of fire and water acting on the ruins of an ancient world, as geologists would have us believe; but the work of an All-wise and Omnipotent Creator, whose providence watches over and directs all things, without restricting second causes, or interfering with those natural laws by which the visible creation is governed.

CHAPTER XI.

Ancient condition of the globe—Coal not an igneous nor an aqueous formation—Structure, form, and substance of coal—Sir R. Kane's theory of coal-formation—Epochs of different coals—Lyell's theory of coal—Phillips' views—Curious relics in English coal-mines—Relics in the coal-mines of Bohemia—Positions of trees in coal-measures—Colliery of Newcastle—Quarries near Edinburgh—Varieties of coal—Culm-pits near Kanturk—Coal and culm veins—Coal-formation in Hesse-Darmstadt—Kilkenny coal-field—Munster coal-field—Peat-coal—Amount of vegetables required to form one bed in the Kilkenny coal-field—Professor Ansted's opinion—Strata alternating with coal—Surfaces of strata in contact with coal—Fibrous coal—Carbonaceous substances—Pitch-lakes, petroleum, &c.—Attempts to produce artificial coal, &c.

Dr. Buckland assumes that "the whole materials of the globe may have been in a fluid or even a nebular state from the presence of intense heat;"* and Lyell observes—"*it may or may not* be true, as the great Leibnitz imagined, that the whole planet was once in a state of liquefaction by heat; but there are, certainly, no geological proofs that the granite which constitutes the foundation of so much of the earth's crust, was ever in a state of universal fusion.† The experiments of Baron Fourier are said to be precisely those which should result if the globe had been formed in a medium of very high temperature, while the astronomical observations of La Place go to prove that there has been no sensible contraction of the globe by cooling, and, consequently, it was never in a state of very high temperature. Lyell, moreover, demonstrates, that the results of Fourier's experiments would apply with equal propriety to the effects of volcanic heat. With the most eminent geologists thus at variance on the first principles of the science, we must be excused if we repose not implicit confidence in geological theories, or if we subject them to the strictest investigation. We are not disposed to adopt or reject any opinion without a previous analysis of the arguments which support it.

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* Geology, vol. i, p. 40.

† Elements of Geology, p. 266.

The absurdity of supposing coal to be an igneous or an aqueous rock, has compelled modern chemists and geologists to ascribe its origin to the vegetable world. They have, accordingly, used every argument they could devise, and every fact which could serve their purpose, in support of this opinion. The structure of some coal, say they, resembles that of wood; it exhibits traces of organization, and contains, very nearly, the same materials as timber, oxygen, hydrogen, and carbon abounding in both. Trunks, branches, and leaves of trees have been discovered in coal. Lignite or brown coal is made the connecting link between true coal and living wood; and thus it is supposed, an accurate view of the course of alteration is obtained.

" The vegetable growth of an immense surface," observes Sir R. Kane, " probably carried together by currents, has been engulfed, and covered with mud and sand, and was then subjected, under the influence of enormous pressure, and probably of an elevated temperature, to those decomposing agencies, by which vegetable matter, when in contact with moisture, is incessantly affected. Under such circumstances wood is converted into coal." The alteration he supposes to have been effected by " the removal of most of the oxygen and some of the hydrogen of the wood. These elements pass off combined with carbon, and form carbonic acid, termed choke-damp by miners, and carburetted hydrogen or fire-damp."*

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* Industrial Resources of Ireland, chap. i.

The distinction between anthracite and bituminous coal is supposed to arise from the geological epoch in which they were formed. The anthracitous is deemed to belong to an earlier period, and, on that account, to have parted with more of its bituminous properties. Upon this alteration which wood and other vegetable matter are supposed to undergo in their chemical composition, geologists base their theory of coal-formation.

The geological hypothesis as regards the accumulation of vegetable matter to constitute the coal-fields, was already noticed.* Sir R. Kane's notions are given above. Lyell's are these:—" In some parts of England, as in Shropshire, certain coal-measures consist of fresh-water strata, and many have originated in a lake, while others, not far distant, were deposited in estuaries to which the sea obtained access occasionally; while a third class was formed at the bottom of an open sea, or in bays of salt-water into which land-plants were drifted. In many parts of France and Germany there are isolated patches of coal-strata entirely free from marine fossils, which repose on granite and other hypogene rocks; they are often confined to an extremely small area, as at St. Etienne in the department of the Loire, at Brassae in the Puy de Dome, at Sarrebrack, also in Silesia, and a hundred other places. All these deposits may have been formed in lakes existing in the islands of that sea in which the mountain-limestone was formed: the minor repetitions of alternate fresh-water and salt-water strata in the coal, have been ascribed to such changes as may occasionally occur near the mouths of rivers; but when shale and grit, containing coal and fresh-water shells, are covered by large masses of coralline rock, and these again by other coal-measures, we must suppose great movements of elevation and subsidence, like those alternations of argillaceous and calcareous rocks in the oolite.

" In adopting such views, we must suppose the lapse of vast periods of time, as the thickness of the coal-strata in some parts of England, independently of the mountain-limestone, has been estimated at 300 feet. Besides, we can by no means presume that all coal-fields were in progress at once, much less that in the same field each mass of strata which is parallel, or occupies a corresponding level, was simultaneously formed. It is far more consistent with analogy to suppose that rivers filled up first one part of a fiord, gulf, or bay nearest the land, and then another, so that the sea was gradually excluded from certain spaces which it had previously occupied."[*]

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* Chap. iv.

Phillips seems equally anxious to establish the vegetable origin of coal, and, consequently, the immense lapse of time necessary for its formation. "It has been conjectured," he remarks, "that the atmosphere might, in those early periods, have an unusual dose of carbonic acid gas, and thus, be more fit to supply the carbon requisite for the growth of such vast forests as then must have encumbered the limited surface of the land. Nothing known to the chemist or natural philosopher, is opposed to the notion that the quantity of carbonic acid gas in the atmosphere may be extremely variable; it would not, indeed, be favourable to the life of animals; but what proof have we of the globe being then tenanted by terrestrial animals? Moreover, speculation apart, let any one calculate the quantity of carbon contained in a single English coal-field, once a part of the living structure of plants, and add the equivalent volume of carbonic acid gas to that small quantity which it now holds; the consequence will be an atmosphere charged with this pabulum of vegetable life, to a degree, perhaps, very favourable to the growth of plants, but certainly detrimental to the life of animals breathing by lungs. Now, surely, it is worthy of attention, that after the coal was deposited, reptile life began to be manifested, and finally, to predominate; while, on the other hand, vegetable life, though the land was much more extensive, and apparently not much lowered in temperature, never yielded again such thick and extensive carbonaceous deposits."[*]

The gratuitous assumptions which these eminent geologists think themselves warranted in making, are too glaring to be passed over unnoticed. What absurdity can be rejected, if " deposits formed in lakes, existing in islands, which were in seas," but which only existed in the imagination of the theorist, must be admitted? What proof has Phillips that the land is now more extensive than it was formerly; or that animal life began to be manifested after the coal was deposited? These are but foregone conclusions, entitled to no consideration, because based on the very thing to be proved, and contrary to facts disclosed by geology, namely, that animal and vegetable fossils, of the earliest date, are contemporaneous, and that those elevating and degrading causes, on which the equilibrium of land and water depends, are equal.

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[*] Principles of Geology, vol. iv.

[†] Phillips' Geology, vol. i, p. 119.

If we add to these theories the following facts, which are given on the authority of the most eminent modern geologists, we will have the substance of all that can be said in support of the vegetable origin of coal. Our task will be then, to meet those arguments by proofs of an opposite nature, and to establish the mineral nature of this formation.

Of all the facts which geologists adduce in proof of the vegetable origin of coal, the fossil-plants of the Newcastle coal-field, and those of the coal-fields of Bohemia, appear the most plausible. " It is the beds of shale or argillaceous schistus which afford the most abundant supply of these curious relics of a former world; the fine particles of which they are composed having sealed up and retained, in wonderful perfection and beauty, the most delicate forms of vegetable organic structure. When shale forms the roof of the workable seams of coal, as it generally does, we have the most abundant display of fossils, and this, not perhaps arising so much from any peculiarity in these beds, as from their being more extensively known and examined than any other. The principal deposit is not in immediate contact with the coal, but about from twelve to twenty inches above it; and such is the immense profusion in this situation, that they are not unfrequently the cause of very serious accidents, by breaking the adhesion of the shale bed, and causing it to separate and fall, when, by the operation of the miner, the coal, which supported it, is removed. After an extensive fall of this kind has taken place, it is a curious sight to see the roof of the mine covered with these vegetable forms, some of them of great beauty and delicacy ; and the observer cannot fail to be struck with the extraordinary confusion, and the numerous marks of strong mechanical action, exhibited by their broken and disjointed remains."* "A similar abundance of distinctly-preserved vegetable remains," says Dr. Buckland, "occurs throughout the other coal-fields of Great Britain. But the finest example I have ever witnessed, is that of the coal-mines of Bohemia. The most elaborate imitation of living foliage upon the painted ceilings of Italian palaces, bears no comparison with the beauteous profusion of extinct vegetable forms, with which the galleries of these instructive coal-mines are overhung. The roof is covered as with a canopy of gorgeous tapestry, enriched with festoons of most graceful foliage, flung in wild, irregular profusion over every portion of its surface. The effect is heightened by the contrast of the coal-black colour of these vegetables, with the light groundwork of the rock to which they are attached. The spectator feels himself transported, as if by enchantment, into the forests of another world ; he beholds trees of forms and characters now unknown upon the surface of the earth, preserved to his senses, almost in the beauty and vigour of their primeval life ; their scaly stems and bending branches, with their delicate apparatus of foliage on all, spread forth before him, little impaired by the lapse of countless ages, and bearing faithful records of extinct systems of vegetation, which began and terminated in times of which these relics are the infallible historians."† If we add to this, the many other evidences which the fossil-plants of the coal-formation furnish, it must be owned that no geological theory appears so ably supported by facts and arguments as the vegetable origin of this *mineral.*

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* Lindley and Hutton's Fossil-Flora, vol. i, p. 16.

† Buckland's Geology, vol. i.

Trees are found in horizontal, vertical, and oblique positions, and this singular fact is observed on the continent as well as in England, " and merits," adds Lyell, " great attention, not only as opening a curious field for speculation, but because it has furnished a popular argument to some writers, who desire to prove the earth's crust to be no more than 5000 or 6000 years old. In the coal-mine at St. Etienne, near Lyons, horizontal coal-strata are traversed by vertical trunks of monocotyledonous vegetables, resembling bamboos. The strata consist of micaceous sandstone, passing into the slaty structure. Since the consolidation of the stone, there has been here and there a sliding movement, which has broken the continuity of the stems, throwing the upper parts of them on one side, so that they are often not continuous with the lower." Notwithstanding this supposed movement, which has broken the stems, and thrown the upper parts to one side, Lyell goes on to say, that " had these trees, as some geologists contend, once formed part of a submerged forest, like that of Portland, all the roots would have been in the same stratum, or would have been confined to certain levels, and not scattered irregularly through the mass."

The authors of the Fossil-Flora tell us, that " in a colliery near Newcastle, a great number of sigillarias were placed in the rock, as if they had retained the position in which they grew, the interior being sandstone, and the bark having been converted into coal. The roots of an individual were found embedded in shale, and the trunk, after maintaining a perpendicular course and circular form for the height of about ten feet, was then bent over, so as to become horizontal. Here it was distended laterally and flattened, so as to be only one inch thick. Another, seventy-two feet in length, was discovered in 1829, near Gosforth, five miles from Newcastle, in coal-grit, the strata of which it penetrated. The wood of the interior was converted into carbonate of lime. In 1830, a standing trunk was exposed in a quarry near Edinburgh ; it was sixty feet in length ; the bark was converted into a thin coating of the purest and finest coal, forming a striking contrast in colour with the white quartoze sandstone in which it lay." In the same quarry in Craigleith, Lyell states that he examined a portion of a tree, fifteen feet long, which rested in strata so unaltered and undisturbed at the point of junction, as clearly to show that they had been tranquilly deposited round the tree, and that the tree had not subsequently pierced through them while they were yet in a soft state.

They (the strata) were composed chiefly of silicious sandstone, for the most part white, and divided into laminæ, so that from six to fourteen of them may be reckoned in the thickness of an inch. Some of these thin layers were dark, and contained coaly matter, but the lowest of the intersected beds were calcareous. The tree could not have been hollow when embedded, for the interior still preserved the woody structure in a perfect state, the petrifying matter being, for the most part, calcareous. It is also clear, that the lapidifying matter was not introduced laterally from the strata through which the fossil passes, as most of these were not calcareous.*

Such are the theories of coal-formation, and the leading facts adduced by geologists in support of its vegetable origin: the following considerations will, perhaps, place the subject in a different point of view, and give the reader more accurate notions of its nature and origin.

There are several varieties of coal; as the BROWN COAL, the subspecies of which, according to Werner, are, *bituminous wood*, *earth-coal*, *alum-earth*, *common brown coal*, and *moor-coal;* the BLACK COAL, subdivided into *pitch*, *columnar slate*, *cannel*, *foliated*, and *coarse coal*. There are, besides, two subspecies of GLANCE-COAL; the *conchoidal glance-coal*, and the *slaty glance-coal*. This latter is the Kilkenny coal. Some of these species of coal are known by different names in their respective localities. Many other varieties are distinguished by the peculiar qualities they possess. The *anthracite* of Kilkenny and of the Munster coal-field, the *bituminous coal* of the north, the *lignite* or *brown coal,* called also *fossil-wood,* found about Lough Neagh, and the *culm* of Kanturk, County Cork, are the varieties found in Ireland.

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* Lyell's Geology.

The pitch-coal sometimes occurs in the shape of branches of trees, but without the woody structure. The moor-coal, found in Bohemia, and other parts of Germany, bursts and falls to pieces when exposed to the air, like the anthracite of Ireland.

The culm of Kanturk, though so hard in the mine as to require, in some instances, to be blasted with gunpowder, yet, on being exposed to the air for some time, it separates, and becomes mere dust. The slaty rock, with which it is associated, undergoes a like alteration by exposure to the elements.

The culm-pits in this locality have been worked from forty to one hundred yards in depth. The culm is not found in one widely-extended bed, as may be naturally expected, had it been produced by a luxuriant growth of plants, or by a mass of vegetable matter, brought together by a river, or deposited in a lake or estuary. No ; it is found in veins which branch off in every direction, and which require the skill and experience of the miner to trace out. This is sometimes done by the appearance of the morning-dew upon the surface. These veins, in many cases, dip to unexplored depths, and sometimes narrow so as to be scarce discernible, and as if lined on each side by this slaty rock or shale, which seems to possess some of the qualities of the culm.

To suppose that vegetable matter could be thus disposed by accident, or by any combination of natural causes, according to the geological theories of coal-formation, is not credible. No trace nor appearance of organic substances is discovered in this locality ; and those who imagine this culm a vegetable production, are certainly bound to explain how plants could have been so arranged in the beginning, as to produce, in successive ages, the curious and numerous coal-veins exhibited in these as n so many other localities ; why the culm and shale undergo similar changes on being exposed to the atmosphere; and where flowed the Blackwater-river, when the vegetables, which formed this coal-field, were deposited in its immediate vicinity.

Sir R. Kane, and many other modern geologists, suppose "enormous pressure and elevated temperature, necessary agents in the conversion of wood into coal; and such, indeed, would seem to us indispensable, if this alteration could possibly take place; and yet, we are told that, in many parts of Hesse-Darmstadt, coal is being actually formed without either *elevated temperature* or *extraordinary pressure*, and that the different stages of transelementation can be traced through the masses of matter from which the true coal is supposed to have been derived. If this be so, as a recent tourist* in Germany affirms, the difficulties in accounting for the change increase, as the faith in modern theories should diminish by such contradictory opinions. If coal be formed without great pressure, how comes it that the specific gravity of coal is far greater than that of ordinary vegetable matter? Can any one imagine that vegetable matter becomes heavier by parting with "most of its oxygen, and some of its hydrogen"? Charcoal is lighter than the wood from which it is obtained, because it has parted with its gases; and are we to suppose, that by a similar process, coal is made heavier?

In the Kilkenny coal-field there are eight beds of coal, separated from each other by layers of sandstone, clay-slate, &c. "The *four-foot coal*, which is the fourth bed in the order of position from below upwards, is eighty yards from the sixth bed, and at a depth of from one hundred to one hundred and forty yards from the surface:"† the lower beds are, of course, far below this. Now, supposing, with geologists, that an ocean was at hand to cover the vegetable matter which formed the lower beds, and supply the enormous pressure necessary to convert wood into coal, and to deposit thereon the matter of which the incumbent sandstone was formed; whence was derived the *enormous pressure* to form the seventh or eighth beds, which are within a few yards of the surface? Should it be said that an ocean or sea supplied the necessary pressure in this case also, then we would have a small district between the Barrow and the Nore submerged, and subsequently raised again, at least eight times, while the surrounding country exhibits no trace or appearance of such convulsions, or aught to indicate any extraordinary revolution.

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* Dr. S——— a young gentleman of extensive acquirements, lately returned from the school of the celebrated chemist, Liebeg.

† Industrial Resources of Ireland, by Sir R. Kane.

If the number of beds in a coal-field denote, as geologists imagine, so many submersions of the district, then the Kilkenny field had eight; the Tipperary field only three, and the Munster coal-field, which extends over the greater part of the counties of Cork, Limerick, and Clare, six such subsidences, and as many elevations. How a deep sea could cover Kilkenny, and not extend to Tipperary; or how this county could be over high-water-mark, while the Munster coal-field was submerged, we are really at a loss to conceive.

Sir R. Kane states that the Shannon passes through the middle of the great coal-field of Munster; but how the vegetables which formed it could have been collected beneath the bed of this mighty river, he does not explain. This coal-field is the greatest in the United Kingdom; the quantity of vegetables necessary to form it must have been immense: whence were they derived? when deposited? In some geological epochs, perhaps, ere the Shannon flowed westward to the Atlantic, and before Ireland could be recognised for what it is at present.

Bogs consist chiefly of vegetable matter. At the surface the mould is generally of a brownish colour, soft and spongy, while the stratum beneath is of a darker colour and more dense. At a still greater depth, the density and darkness of colour increase. When in contact with clay, and at great depths, the mould approximates the colour and density of coal; but still the distinction between such matter and true coal is very evident. In fact their properties are altogether different. The turf-coal contains far more earthy matter, much less gas, emits a different flame, is sooner consumed, and has not the external appearance, the structure, the fracture, nor the specific gravity of true coal. Were such matter capable of becoming mineral-coal, we may expect to find coal-beds beneath bogs which have existed thousands of years. And if thousands of years will not suffice to effect such a change, how can it be shown, that tens of thousands, or even millions, would suffice?

But it will be said that coal is produced from wood, and not from compressed peat. Be it so; there are objections to this opinion also. The fourth bed in the Kilkenny coal-field extends over five thousand Irish acres, and is calculated by Griffith to contain over sixty-three million tons of coal.* As the specific gravity of coal is about double that of wood, or ordinary vegetable matter, it follows, that, to produce this single bed of coal, a weight of wood equal to one hundred and twenty-six million tons would be required; and as anthracite coal has parted with almost *all* its oxygen and hydrogen, the quantity of woody matter necessary to form this bed would be much greater still.

This opinion is supported by Professor Ansted, who, in speaking of coal, says that, "in some places, coal was found extending in depth, from a few inches, to thirty or forty feet, and, in many places, occupying immense tracts of ground. But its extent gave us no idea of the amount of vegetation then existing; for, of course, an immense quantity of those trees died without becoming coal, and those that had, were reduced naturally in bulk, in consequence of the compression that ensued."† In the opinion even of geologists, we do not overrate the quantity of wood necessary to form one bed in the Kilkenny coal-field, at one hundred and twenty-eight million tons; we might, without exaggeration, assume it at a much greater amount.

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* Industrial Resources of Ireland, by Sir R. Kane.

† Geological Lectures, delivered in Cork, July, 1846.

Now 5000 acres contain 800,000 perches, and 128 million tons of timber, spread over 800,000 perches, would be 160 tons to each square perch, or nearly four tons to every square yard. The absolute impossibility of having such a mass of vegetables grow on such a space, and the improbability of having them brought thither and piled together by any combination of natural causes, are sufficient to warrant the conclusion, that this bed of coal, at least, is not the production of vegetable matter.

If we suppose a mass of vegetables collected to one spot by water, or by the prostration of some immense forest, its upper surface must be very uneven. Any deposit made upon this by water, must, evidently, mingle with the wood; and whether the deposit would have been suddenly consolidated, or long subsequently by slow gradations, the woody matter should be found embedded in the superimposed strata. Is this the case? No; the very reverse is the fact, as the following passage will prove: "The terrestrial matters which compose the solid parts of the earth, in coal-mines, are disposed in strata, beds, or layers, the under surface of one bearing against or lying upon the upper surface of that below it, which last bears or lies on the next below it in the same manner. These strata consist of very different kinds of matter, such as freestone, limestone, metalstone, coal, &c. Some of these strata are of considerable thickness, being often found from one hundred to two hundred feet or upwards, nearly of the same kind of matter from the superior to the inferior surface; and others are found of the least thickness imaginable, one inch or less. All these strata are divided or parted from each other laterally, either by thin, even, smooth, polished surfaces, with very thin laminæ of soft or dusty matter between them, or else only by the surfaces closely conjoined to each other, without any visible matter being interposed; yet the different substance of each stratum is not in the least intermixed."*

Could it be possible for water to deposit on a mass of vegetable matter, brought together by any ordinary means, a layer of any mineral found in coal-measures, which could form with this vegetable substance an even, smooth, or polished surface? The mineral being gradually deposited from the water, could not be of a nature to compress the vegetables, so as to present at the top a smooth or even, much less a polished, surface. Besides, as shale is but indurated mud or clay, its specific gravity is generally less than that of sandstone, limestone, or ironstone, and consequently, could not intervene between those rocks and the underlying coal; so that geological theories are quite at variance with facts: and hence, either coal is not of vegetable origin, or the geological theory of coal-formation vanishes.

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* Encyclopædia Britannica.

The *fibrous coal* which is found " in the different coal-fields of England, burns without flame, though some varieties of it scarcely yield to the most intense heat. It is not certain that this mineral is wood mineralized; several of the varieties may be *original calcareous matter*, crystalized in fibrous concretions."* It is not certain whether or not this species of coal is wood mineralized, and yet this fibrous coal " is met with in the different coal-fields of England."

Either this is of vegetable origin, or no coal in the mines in which it is found can be so. If the other species of coal have derived their origin from the vegetable world, how could this species be referred to any other source? Are we to suppose, that after the vegetables were deposited, which constituted the other species, " original carbonaceous matter" was introduced among them? We readily grant, that fibrous coal *is* an original carbonaceous matter, and we consequently infer, that all the other varieties of coal, with which it is associated, are also *original carbonaceous substances.*

If geologists are not certain of the vegetable origin of fibrous coal, how can they be certain of the vegetable origin of anthracite coal, or of any other kind that does not exhibit the woody structure? Indeed, neither vegetable form nor structure, nor even substance, will demonstrate vegetable origin. Calcareous and ferruginous substances assume vegetable forms.* Vegetable structure is exhibited in some species of asbestos† and carbon; the principal vegetable substance is pure in the diamond, and yet, no one pretends to refer any of these to the vegetable world. Anthracite coal is almost pure carbon, and on this account only, can it be said to be of vegetable origin, for it has neither the structure nor the form of wood; and if, for this reason, it must be deemed a vegetable production, we cannot exclude culm, petroleum, plumbago, &c., from the list. If these substances are to be considered as derived from vegetables, why should a substance composed of pure carbon be rejected from this class of bodies? Kilkenny coal, and diamond (the hardest and most valuable of all known bodies), are nearly identical in substance. Are we to refer them to the same origin? Is diamond a vegetable production? If not, where shall we draw the line of demarcation between minerals and vegetable productions?

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* London Encyclopædia, vol. v, p. 80.

Culm and anthracite coal are deemed earlier formations than bituminous coal, as having parted with most of their inflammable matter; and why not assert that black-lead or plumbago is still earlier, and has lost all its bituminous properties? Such would be no extravagant conclusion, but where could we terminate such a train of inductive argument? Should limestone, which contains so much carbon, be left out of the catalogue? No; and some geologists have referred it to some "early and obscure stage of organic existence," precisely on account of its carbon. Were this mode of reasoning admitted, there are but few substances in nature which may not be referred to the vegetable kingdom, while that very kingdom is known to subsist by means of the inorganic world. If, then, coal be a vegetable production, and limestone, chalk, and silica, be derived from the animal kingdom, it will be very hard indeed to prove what are *true* mineral bodies.

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* See chapter xii.

† London Encyclopædia, vol. iii. p. 27.

Were we to admit the vegetable origin of any species of coal, we could never determine the limits: neither the bituminous lakes of Maracaibo or Trinidad, the petroleum springs of Italy or Irawady,* the plumbago of Cumberland, nor the calcareous formations, could arrest our progress. If coal be a vegetable production, why have not chemists succeeded in producing it artificially? We have all sorts of wood, and every degree of heat and pressure at our command; and yet no coal has ever yet been produced from vegetables, by art. Several attempts have been made, but they have all been failures. Liebeg states, that a piece of wood, which by accident remained in the boiler of a steam-engine, was *almost* converted into coal in a few hours by the enormous pressure of the steam; and this is cited to prove that wood *may* be changed into coal. It is as unnecessary to have recourse to the authority of this distinguished chemist for the truth of an experiment which may be tested in any steam-boiler, as it is to the authority of Dr. Ehrenberg, of Berlin, to know if a piece of chalk is composed of the shells of animalcula. These are points upon which any intelligent person may satisfy himself; nor will he, we presume, be more convinced of the fact by the assertion of a philosopher, than by his own experience.

A piece of wood subjected to the pressure of steam, would be altered in appearance and specific gravity; but it would not be changed into coal, nor *almost* into coal. Its pores may be filled with water; but it could not part with its gases, nor "be subject to those decomposing agencies by which wood is said to be converted into coal."

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* "Many springs in the territory of Modena and Parma produce petroleum, but, perhaps, the most powerful yet known are those on the Irawady, in the Birman Empire. In one locality, there are said to be 520 wells, which yield annually 400,000 hogsheads of petroleum. Fluid bitumen is seen to ooze from the bottom of the sea on both sides of the island of Trinidad. Dr. Nugent relates, that about seventy years ago, a spot of land on the west coast of Trinidad, sank suddenly, and was immediately replaced by a small lake of pitch."

Some suppose this mineral pitch is derived from coal; but as there is no coal in Italy, (according to the London Encyclopædia), the petroleum of Modena and Parma cannot be thus accounted for.

CHAPTER XII.

Positions occupied by coal—Burrowstownness, Newcastle, Durham, and Cumberland coal-mines—Coal in the Andes—Coal, limestone, and cinnabar—Coal-field of Virginia—Coal and iron—Simple substances—Bodies identical in substance and properties, but different in origin—Links which connect different creatures—Time necessary to form coal—Different geological opinions—Oblique and vertical trunks—interior of fossil-trees—Pressure —Facts opposed to the theories of coal-formation—Grit and shale of coal—Vegetables in coal—Experiments of Lindley—Wood converted into iron pyrites—Shells in coal—Effects of coal upon wood—Bones changed into coal—Burning coal-mines—Fishes in coal-shale—Bituminous liquids—Kentucky cavern—Works of creation.

The singular positions in which coal exists afford presumptive evidence of its mineral origin, and may be regarded as proof that no vegetable deposits could have been made in localities so peculiarly circumstanced.

The coal-bed at Burrowstownness, under the sea, was the wonder of all who saw it. It was wrought for several years, till an unexpected high tide drowned the whole at once. How coal could have been formed there of vegetable matter, cannot be explained by any probable or rational theory. In the Durham and Newcastle coal-field there are in some parts no fewer than forty beds of coal, the coal-measures being eighty-two in number, consisting of alternations of coal, sandstone, clayslate, &c., forming an aggregate thickness of sixteen hundred and twenty feet. If these particular portions of the coal-field were submerged as often as there are beds in these coal-measures, the history of coal-formation in this district would shame the tales of the German baron whose name is proverbial for all that is marvellous. In the collieries near Whitehaven in Cumberland, the mines are sunk to the depth of a hundred and thirty fathoms, and extend under a sea, in which the largest vessels may float. The descent to the lowest vein is through long galleries hewn out of the solid rock. Geologists alone can *conjecture* at what time these coal-beds were formed, if not when the ocean which rolls above them was created.

In the Andes, beds of coal occur at the elevation of 8,650 feet above the level of the sea; and at Huduco, in Peru, at the extraordinary elevation of 14,700 feet.* How will geological theories account for this? By supposing, of course, that these regions were up-heaved after the coal-beds had been formed. In that case, we must suppose those summits to have been sea-bottoms as often as there are beds of coal in each coal-field, and at length to have been raised to their present positions by some extraordinary revolution. Or, perhaps, those summits where vegetable life can now scarcely exist, had been, at some *geological* era, covered with luxuriant forests, from whose destruction these coal-beds were formed!

Is it because such revolutions in nature are possible to Omnipotence, that they must be admitted as natural consequences resulting from known causes? Such admission would not be granted to any other department of human knowledge.

Coal and cinnabar are also found in these regions enclosed in limestone of a silicious base. Which of these was first formed? Could cinnabar have existed there during the formation of the coal or limestone? If coal and limestone were formed previously to the introduction of cinnabar, how has that metal been produced? These questions cannot be satisfactorily answered consistently with modern geological theories; but they present no difficulty when referred to the act of creation, by which these different minerals were at first associated.

There are extensive coal-fields in Virginia,† in which the beds of coal alternate with beds of iron-ore; and it is a singular fact, that these minerals are generally found in the same district, if not in the same locality. Sir R. Kane alludes particularly to this circumstance in his much-admired work, *The Industrial Resources of Ireland.* If coal be a vegetable production, geologists are bound to explain how iron comes to be so intimately connected with it. Can it be that iron also derives its origin from the organic kingdoms? And if not, why does ironstone so often alternate with coal? The geological theories of coal-formation lead us to suppose that iron must be a deposit from water, as well as the sandstones or limestones of coal-measures; and if so, is it not equally just to conclude, that copper, tin, lead, silver, and all the other metals, are also deposits from water? In that case, there will be no difficulty in accounting for mineral veins, whose formation has hitherto baffled all geological research. Iron-ore is found associated in great abundance with the coal of America; and as all geologists do not grant that mineral veins have been filled by deposits from water, we are perfectly justified in saying, that iron-ore is not an aqueous formation.

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* London Encyclopædia, vol. ii, p. 279.

† A high hill, near Pittsburg, U. S., is composed principally of coal. How was this formed? Geological theories should undergo some modification to suit this singular case.

But whence came the iron found incumbent on the coal? This is for geologists to answer. We cannot refer the association of these two minerals, so useful to man, to any other cause than the manifest design of the All-wise Creator, who, in giving us *iron,* gave us also *coal,* without which the iron would be comparatively useless. Even in the material world, the gifts of God are not bestowed by *halves.* Man received dominion over the earth, and all that it contains, and with this jurisdiction, every physical means of rendering all things subservient to his purposes. Metals would have been useless to him were they not near the surface, within his reach, and had he not the means of fusing them. Coal and vegetable matter were, accordingly, provided by that merciful Providence, which has prepared an antidote for every poison, and remedies for all diseases. If geologists can assign a more natural or rational cause for the association of coal and iron than this, let them do so.

There are so few simple substances in nature, that several of the same kind must necessarily exist in compound bodies of different natures and of different origins; and hence, the rule of determining the origin of bodies by the identity of substances, is fallacious. This has led to the mistake, that coal is a vegetable production. Wood and coal possess many common properties, but this will not prove identity of origin. Chemists are fully aware, that bodies very different in origin may yet be composed, not only of the same substances, but of equal portions of these selfsame elementary substances.* Every one acquainted with the *atomic* theory can bear testimony to this truth. What two substances can be more distinct as to origin than nitrolin† and animal flesh; and yet, what bodies more like in substance? Both are composed of nearly equal quantities of *carbon*, *hydrogen*, *nitrogen*, and *oxygen*. Were we ignorant of the origin of these substances; and did we know them only by analysis, we would instantly infer that one was identical with the other, or derived from it: so it is in the case of coal; geologists *want* to account for this mineral as a geological formation; to rank it as an igneous or aqueous rock would be absurd, and they are forced to the alternative, as it were, of considering it a vegetable production.

Malte Brun describes the fruit of the breadfruit tree as " like new-made wheaten bread." Were we to judge of these two substances by mere external qualities, we would probably refer them to the same origin. The produce of the Chinese tallow-tree, and the milk of the cocoa-nut, contrasted with the animal substances, tallow and milk, may probably lead to a similar conclusion. These substances, so different in origin, resemble each other more nearly than coal *does* wood; we cannot, therefore, fairly deduce a consequence in one case, which we know would be false in many other similar cases.

The works of creation *pass into* each other by such insensible gradations, that it is difficult to decide to which class the links belong that unite the different orders of creatures. Coal is the link which unites the mineral and vegetable kingdoms, and lignite may be regarded as the nearest approximation of the inorganic world to living wood. Art sometimes imitates nature so exactly as to deceive the most experienced; and will it be supposed that nature cannot imitate, yet more exactly, her own works? She can, and, accordingly, we find the vegetable form assumed by a variety of substances, as shall be shown hereafter.

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* " When the chemist determines that two bodies have the same ingredients, he is ignorant of the manner in which these ingredients are combined." Ency., vol. xiv, p. 690.

† A vegetable substance, (humus).

Leaves and branches of trees which have no analogous species now existing on earth, are found in some coal-mines. Is it not exceedingly strange that fossils of existing species are not also found? If, in the ordinary process of nature, four thousand or five thousand years will not suffice to change wood into coal, who can say that a greater length of time will produce the effect? Timber is found in bogs and river-beds, where it must have lain for thousands of years, and yet it is not changed into coal. The wooden beams in Herculaneum exhibit not the slightest appearance of coal or lignite, after the lapse of seventeen centuries, though neither heat nor pressure was wanted. Submarine forests exhibit no appearance of coal, nor is there any proof that the drift-wood of the Mississippi, or any in the deltas, formed within the historic period, is yet converted into coal, or likely to be so hereafter. Can it be that the existing vegetables are incapable of such a change? and, if so, why will not chemists tell us in what particular quality existing races differ from the vegetables of the olden times?

But whence came the trees, the branches, the delicate foliage, and all the variety of plants, which the *Fossil-Flora* enumerates? Whence were derived the plants of the Bohemian and English coal-mines? These are important questions, and require a few preliminary observations.

“ It is rather singular,” remarks Lyell, “ that in three hundred species of terrestrial plants, enumerated by M. Brongniart, as proper to the coal, that scarce any vestige of flower, seed, or fruit is found, though leaves, in some instances, are recognised. The leaves, or more properly speaking, the fronds of ferns exceed in number all other plants in the shale of coal. These fronds are found, accompanied by large fluted stems or trunks of trees, which have been squeezed downward, flattened as they lay prostrate in the shale, so that the opposite sides meet, but which, when they occur in the accompanying grit or sandstone, and are placed obliquely or vertically, are round and uncompressed."* It is, indeed, singular that leaves would have been preserved, while fruits, seeds, and flowers perished! and it is equally singular, why ferns should be so abundant. Mr. Lindley differs in opinion from M. Brongniart, and supposes some sigillaria† were not tree-ferns. M. B. replies by saying, the living genera of ferns do not attain the size of the fossil ones, in the present state of the globe ; though Lyell absolutely denies "the existence of any ancient causes, as differing materially from modern causes."

These conflicting opinions involve the subject in difficulties, and are calculated to throw doubts on the geological theories of coal-formation; but when facts are directly opposed to each other, we are left no alternative but to conclude, that coal is not a vegetable production, or that the geological theory of coal-formation is fallacious.

Lyell describes the trunks of large trees, as they lay prostrate in shale, squeezed down and flattened, so that the opposite sides meet, and this by the violent pressure of the incumbent strata. Dr. Buckland states the roof of the Bohemian coal-mine to be "covered with a canopy of gorgeous tapestry, enriched with festoons of most graceful foliage, flung in wild, irregular profusion over every portion of the surface." How is it possible to reconcile these discrepant statements? Enormous pressure is required in both cases. In fact, the shale which contains the delicate leaves, and bending branches, and graceful foliage, must have been itself formed by enormous pressure.* Moreover, it lies under a vast rock, which must have been formed over it, and which, according to the geological theory of coal-formation, must have pressed upon it. How, then, are we to account for the perfect preservation of tender branches of festoons and flowers, &c., under circumstances similar to those in which large trunks were flattened, and squeezed together till the opposite sides met?

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* Geology, vol. iii, p. 428.

† Most of the trunks found in coal are called *sigillaria*.

The interior of the oblique and vertical trunks found in coal-measures are converted into sandstone, or filled with calcareous, or some other extraneous matter, while the bark only is converted into coal. Dr. Buckland says, "the vertical position of these trunks is only occasional and accidental; they lie inclined at all degrees throughout all the strata of the carboniferous series, but are most frequently prostrate, and parallel to the lines of stratification, and in this position are usually compressed; when erect, or highly inclined, they retain the natural shape, and their interior is filled with sand or clay, often different from that of the stratum in which their lower parts are fixed, and mixed with small fragments of various other plants. As this foreign matter has thus entirely filled the interior of these trunks, it follows that they must have been without any transverse dissepiments, and hollow throughout, at the time when the sand and mud and fragments of other plants found admission to their interior. The bark, which alone remains, and has been converted into coal, probably surrounded an axis composed of soft and perishable pulpy matter, like the fleshy interior of the stems of living cacteæ; and the decay of this soft internal trunk, while the stems were floating in the water, probably made room for the introduction of sand and clay."†

If these trunks be taken as proofs of the vegetable origin of coal, they must have formed part of the vegetable mass that composed the coal-beds with which they are associated; and they must have been deposited at the same time, and must have, consequently, floated in the same water, and been subsequently covered with the same strata which compressed the prostrate trunks, and caused the enormous pressure necessary to form the coal-beds.

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* Shale, according to geological theories, is but indurated mud or clay.

† Buckland's Geology, vol. i, p. 471.

Now, if the vertical and oblique trunks were deposited at the same time with the coal-beds they traverse, how did it happen that they were not converted into coal as well as the others? Why was not the interior of the prostrate trunks converted into sandstone as well as the interior of the oblique and vertical trunks? Will the mere position of the tree account for so extraordinary a difference? One tree is said to be round while it preserved its perpendicular position, but the bent part flattened even to the thickness of an inch. This could not have been the effect of pressure according to the laws of hydrostatics; and the geological theory of coal-formation neither claims nor sanctions any deviation from those laws. If two trees be immersed in deep water, the *shape* will not be affected by the pressure of the fluid, as the pressure on all parts is perfectly uniform. On the horizontal tree, the pressure is something greater on the sides than on the upper surface, and hence, the trunks could not have been flattened by the pressure of water. The case will be similar where deposits are made from water upon prostrate trees or any other bodies. The soft mud, or any other precipitate from water, will press with equable force on all sides, and cannot possibly distend laterally the trunk upon which it presses. To produce such an effect, the incumbent body should be in a solid state, and no counteracting force at the sides to resist the downward pressure; a case which no geological theory contemplates.

Buckland, Kane, Lyell, Phillips, M'Culloch, Hutton, and many other eminent geologists, not only grant that enormous pressure is necessary to convert wood into coal, but contend that such is absolutely required. If so, how can we suppose this enormous pressure to have been applied to the vertical trees whose barks only are changed into coal, while their interiors consist of sandstone, carbonate of lime, or indurated mud or clay? If this enormous pressure had been applied before the interior was petrified, why was not the upright tree flattened like those that are prostrate? If the equable pressure on all parts prevented this, it should also have prevented the prostrate trees from being flattened. If the pressure was applied after the interior had been petrified, how was the bark preserved uninjured during the process of lapidification? How was the matter which produced the enormous pressure prevented from acting during that period? Or how was the petrified matter introduced to the interior of the tree without affecting the bark? These facts are directly at variance with the geological theories of coal-formation, and justify us in concluding these theories to be false and imaginary.

Lyell asserts, that " most of the strata through which one of these trees had passed, were not calcareous, yet its interior was carbonate of lime;" from which circumstance he infers, that " the lapidifying matter was not injected through the sides. It must, therefore, have been introduced through the end, as the lowest of the intersected beds was calcareous. However, as all the matter was not calcareous, it must be inferred that portions of the matter from the beds not calcareous were introduced laterally." As the matter in the lower bed was like that of the interior of the tree, this matter must have been forced up by pressure, through the end, just as water ascends in a pump. For this, the tree must have been hollow, and the bark only left to bear the lateral pressure. We doubt if this could have been possible; we are certain it is not probable.

In the actual coal, no trace of vegetable form, no impression of fishes, no testaceous remains, are ever found; all these fossils exist only in the grit or shale of coal. And had coal been formed as geologists say, it would be quite natural to expect these fossils in the very heart of coal.

The presence of so many vegetable forms in coal-measures, remains yet to be accounted for. We cannot hope to remove all the difficulties which this subject involves, nor to answer all the objections which theorists may urge against our opinions; but we can, at least, substitute for those we have been combating, other causes more rational, and more in accordance with those operations which nature has at all times been producing.

Wood is rapidly converted into sandstone, silica, carbonate of lime; and it is a very curious fact, that parts of many trees of the submarine forests on the coast of Hants have been converted into iron pyrites. May not trees immersed in coal-fields be also converted into coal similarly? Petrified trees are found in calcareous and silicious strata, yet no one thinks of maintaining that these substances have been produced from vegetables; and is it not as rational to think that vegetables may be carbonized by coal, as silicified by silex, or converted into carbonate of lime by calx? Lyell admits, that "hot springs charged with carbonate of lime, silex, and other mineral ingredients, may issue at great depths, in which case every pore of the vegetable tissue may be injected with the lapidifying liquid before the smallest decay commences. The conversion also of wood into lignite is probably more rapid under enormous pressure."*

And may not coal-oil, which in some places is found as liquid as water,† under enormous pressure and other peculiar circumstances, be injected into wood, or into the pores of any other vegetable, and fossil-trees and lignite be thus produced? We do not deny either the possibility or the probability of having many plants in coal-mines produced by such means. Our objections are not against the carbonization of wood, but against the vegetable origin of coal. Attempts to change wood into coal by artificial means have failed; natural operations may have been more successful. Wood is petrified by natural means. Artificial petrifactions are things unheard of. Petrifactions, however, occur but in certain localities where the petrifying substances had previously existed; and so it is with the fossil-flora of coal; no vegetable is converted into a coaly substance unless, perhaps, in places where coal had been created; and hence, wood or vegetable matter becomes not coal in bogs, or river-beds, or deltas, or such places, though moisture and pressure were abundant, and length of time, even thousands of years, not wanted.

Hutton states, that "in part of the coal-field of Northumberland and Durham, fossil-shells of a species of unio occur in considerable abundance, in a shale containing plants of the carboniferous period, and overlying a bed of coals. The shelly stratum is about eighteen inches thick, and extends over an area of five thousand square feet."

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* Principles of Geology, vol. iv, p. 301.

† See chap. xiii.

The presence of these shells and plants proves that both were brought thither in mud or clay, which was subsequently indurated into shale, and, consequently, distinct from the underlying coal. In like manner it may have happened to many other vegetable fossils, as all these are found in the shale or grit of coal, and not in the coal itself.

Wood, in contact with coal, may assume its nature, as well as it does that of sandstone or silica; and were we to judge by their respective qualities, we may, with more reason, imagine the change of vegetables into coal than into silicious or calcareous rocks. Lyell mentions that certain bones, found embedded in coal, were actually converted into a species of coal;* and if bones can be so changed by contact with coal, is it unreasonable to suppose that vegetables may undergo a like change? As no one will say that all coal is derived from the animal world, because of this peculiar species of coal; so no one should conclude that coal was of vegetable origin, because of the vegetable fossils it contains.

Vegetables long exposed to the influence of gases, so abundant in coal-mines, would be very much altered; and if so circumstanced as to be in contact, or immersed in mud, which heated coal might harden into shale,† they may be so penetrated with the coaly matter as to exhibit nothing of vegetable appearance, save the bare form. In such cases wood may become coal; or perhaps we should rather say, that coal may occupy the place of wood. If coal, expanded by heat, is forced into casts or moulds formed by vegetables in shale, it will assume the form of such vegetables. Bituminous liquids may, in a variety of ways, so impregnate wood or any other vegetable matter, as to leave only the form remaining. But this process is quite distinct from the geological theory of coal-formation, which pretends to change wood into coal, without the aid of any pre-existing coal or other bituminous matter.

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* "In Cadibona, between Savona and Carcara, many entire jaws and other bones of an extinct animal have been found in coal-beds, the bone being itself changed into a kind of coal."—Geology, vol. iv, p. 153.

† Lyell says, (vol. iv, p. 125) that at "Russel's Hall, near Dudley, coal-mines have been on fire for ages, and that beds of shale of considerable thickness, lying over the burning coal, have been baked and hardened so as to acquire a flinty fracture." The remains of fishes are found in the shale of coal on the banks of the Rhine, an evident proof that this clay, in contact with coal, was hardened before the fishes were decomposed; and the absence of any such remains in the coal, shows the coal to have existed previously to the formation of this stratum.

What can be more natural than to think that vegetables immersed in petroleum, naphtha, or any of the forms which liquid bitumen assumes, would be so penetrated with this substance as to become coal? There are cases of this kind, in which vegetable forms, like those which the Bohemian coal-mines display, may be speedily and perfectly formed. Coal changes clay into bituminous shale, and why not admit its power of changing wood into coal?

Coal existed as a mineral from the beginning, as well as granite or limestone, but, like all other minerals, was subject to the influence of natural causes. Heat, pressure, decomposition, &c., combined with the revolutions in the earth's crust, have produced considerable alterations in this substance, and by these simple but natural means, all the phenomena connected with the coal-strata may be accounted for.

Even without the aid of vegetables, why should it be deemed more extraordinary that coal, in peculiar circumstances, should assume vegetable forms, than that many other minerals should do so? Gold occurs "in vegetable forms like the branches or twigs of plants."* A mass of iron, in the shape of a tree, with its branches, exists in the district of St. Jago del Estero, in South America."†

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* London Encyclopædia, vol. x, p. 283.

† Ibid. vol. xii, p. 177.

Silver is found sometimes to resemble branches of trees, and is therefore called *dendrites.* In the mines of Potosi, when newly extracted, it is not unlike small branches of fir.* Water, in becoming ice, assumes every conceivable form.† In the celebrated natural cave in Kentucky, "calcareous incrustations are rapidly forming; nature is shaping columns, festoons, draperies, and groups of statues in profusion. The summits of the hill touch the vault, which, in this place, is pierced with excavations, and ornamented with calcareous festoons in large folds. If you raise your head, you see a hole festooned with calcareous incrustations: they are like bunches of grapes in graceful clusters. By using hands and feet, you ascend them, although with difficulty, and the most magic sight opens immediately before your eyes: you find yourself transported upon garlands and heaps of black and white grapes. The masses of this beauteous fruit drop down to the ground; the floor is strewed with them. A pure water, which may be taken for their juice, trickles along the garlands, the lines of their draperies, &c. The figures are not only columns and draperies, but also leaves, flowers, roses, &c., &c."‡

The cavern of Cango, in South Africa, near Georgetown, is also very remarkable; we quote from a description by Lieutenant Sherville, who "states it to be a vast cavern of one hundred and fifty feet square, by fifty feet high, all studded with pillars of alabaster, some as white as snow, others as transparent as crystal. The column in the centre overtops all the others; it is fifty feet high and nine in circumference. One would say, on surveying these columns, that they had been carved out by a giant, and finished by a jeweller, so imposing is their size, and so delicate the chiseling. At the two extremities, the hall is tapestried with draperies and garlands of flowers, which are entwined within each other, forming elegant arabesques. All around, the crystals assume the forms of different objects. Here the imagination seems to discover a Catholic altar, surmounted with all the ornaments which are used in grand solemnities. Nature has here sculptured out high and superb candlesticks, vessels, vases, altar-steps, and thuribles. In another view, there is a collection of flowers, trees, and animals; among which you can easily distinguish the head of a gigantic bull."

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* Thomson's Chemistry, vol. iv, p. 401.

† Encyclopædia, vol. xi, on Icebergs.

‡ Annals of the Faith, vol. v, p. 335.

Sometimes the travertine, near the village of San Vignone, assumes precisely the botryoidal and mammillary forms; and can we forget the countless vegetable forms which the coral assumes? In a word, so many substances take vegetable forms, that it should be a matter of no surprise if coal also assumed such forms, under circumstances with which we are as yet unacquainted. These vegetable appearances are not less striking than those of the coal-mines already alluded to; and yet no one imagines them vegetable productions, much less that metals and calcareous rocks derive their origin from the vegetable world. It is equally fallacious to infer that all coal is of vegetable origin, because of the leaves, branches, trunks, &c., into which it is sometimes shaped.

By some the earth is regarded as a heap of confused matter—as the ruins of an ancient world. They should rather view it as it had been in coming from the hands of the Creator, resplendent in beauty and teeming with fertility, and before the unhappy fall of our first parents, by which it was stricken with sterility, and subsequently subjected to the dreadful ravages committed on its surface by the deluge. Even as it now is, the saintly mind and the sublime genius of Fenelon found the Great Creator left nothing imperfect in his works. Created intelligences could suggest no improvement in any individual of the animal or vegetable kingdoms. Minerals, too, are no less perfect, each according to its kind. The earth, taken as a whole, is no less perfect than the sun or moon or any of the heavenly bodies. Enormous masses of rock form the groundwork of its external crust; innumerable veins traverse its strata in all directions; currents of magnetic effluvia sweep over its surface, not merely "to give direction to the compass of the mariner," but to fulfil other important objects, whose nature or amount we cannot duly estimate ; gases, which form so vast a proportion of ponderable bodies, are being constantly disengaged, to supply materials for the organic kingdoms ; and rocks are being reconsolidated to serve as store-houses, from which future supplies of earths and gases may be procured. Heat is generated in the bowels of the earth, to keep up the natural warmth necessary for organic existence, as carbon is burned in the lungs of animals, to preserve the natural heat of the body. Simple elements are united to produce compound bodies ; organic beings are supported by inorganic substances. Water, in passing from the liquid to the solid state, assumes appearances more fantastical than the clouds or the lightning of heaven ; calcareous matter is shaped into leaves, flowers, fruit, &c., and with all nature in such a state of action, would it be too much to suppose that coal also should share in the general movement, and assume, under peculiar circumstances, the forms of vegetables ? Coal exposed to heat, pressure, &c., may send forth bituminous liquids, and these may flow through strata, occupy the spaces left vacant by decayed vegetables, and solidifying, may exhibit all the appearances displayed by the English and Bohemian coal-mines. This view being admitted, would be consistent with natural operations and those known laws by which the material world is governed, the necessity of countless ages for producing such effects would be obviated, and geological theories would not be overturned by later discoveries.

CHAPTER XIII.

Effects of pressure in coal-mines—Alternate strata—Metals in coal—Metallic ores—Coal-oil—Effects of coal-oil on vegetables—Difficulties of the coal-flora obviated—Rocks incumbent on coal—Early state of the atmosphere—Animals and vegetables coeval—Mutual dependance of the animal and vegetable kingdoms—German forests—Bogs—Source of carbon—Vegetable physiology—Atmosphere—Different densities of the atmosphere—Volume of the atmosphere—Amount and weight of carbon in the atmosphere—Opinions as to the origin of carbonic acid—Consequences of the first opinion—Consequences resulting from the second opinion—Carbon in other bodies—Recapitulation.

Enormous pressure, deemed so necessary to convert wood into coal, defeats the strongest arguments adduced in support of the vegetable origin of this mineral, as, leaves, branches, festoons, foliage, &c., could not have been preserved in such circumstances ; nor could the bark of trees, whose interiors had perished, have maintained their form, during the process of transelementation, under such enormous pressure.

There are many instances in which the same coal-field contains only one description of coal,* though the beds are separated by layers of shiver, sandstone, ironstone, &c. Had the theory of coal-formation been true, we should expect a very different result ; for, if the upper beds were bituminous, the lower ones should have been anthracitous, in consequence of the great length of time which intervened between their formation. Besides, the vegetables which formed the different beds should have been different, and differently affected by the menstrua which made such very different deposits.

If coal be not a mineral, how comes it to pass that veins of gold, silver, and other metallic ores, are sometimes found in coal-mines ? Are we to suppose, that these ores were brought thither after the vegetable matter of the coal-field had been collected? In that case, the ores would seem to be later productions of nature than vegetables, although we are told, that metals are simple or uncompounded bodies, and, consequently, were created with the other elementary substances.

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* London Encyclopædia, vol. v, p. 85.

These ores appear in coal-mines, not as if brought thither by currents or other natural revolutions, but as in other mines; not as if accidentally introduced, but as having existed there from the beginning.

Metallic ores are found in various descriptions of slate, where no coal exists. If these ores are later formations than the slate, we ought to be told how they were formed, and whence they came. If slates of the same geological epoch alternate with beds of coal, then coal is an earlier formation than slate, or the metals found associated with those slates. But ores of the same metals are found in primary rocks. Are we, then, to regard coal as anterior to those primaries? Geologists will admit no such inference, though such indeed may be fairly drawn from these premises. And there are other facts to justify such a conclusion, if we adhere to geological theories. The different minerals are so intermingled in the earth's crust, that the most dissimilar are often found united. Tin contains iron and copper; silver is found united with lead; gold with iron, copper, silver, &c. In a word, wherever one of these is found, any other may be there also. How they could be present in coal, unless by the first act of creation, is a mystery which the geological theory of coal-formation cannot explain.

The oil which oozes from a stratum of coal in India, is as liquid as water, when taken out; by exposure to the air it becomes of a darker colour and thicker consistency. Now, were this oil, at great depths and under enormous pressure, to come in contact with vegetables, it would penetrate their pores and alter them materially, nay, change them to a kind of coal.

Asphaltum, or mineral tar, abounds in various parts of the world, as Trinidad, Albania, Palestine, Russia, &c.

"Considerable quantities of this substance often issue from the strata of stone-quarries in the county of Caithness. At first it is nearly as fluid as water, but by exposure to the air, it acquires a darker colour, and the consistence of tar. By long exposure, it even becomes hard, and as black as jet."*

Were a quantity of this matter to flow through strata in which vegetables had been previously deposited, it would occupy the place of those which had decayed, mingle with them, and re-form, as it were, those which were perishing, penetrate the pores of others, and, where the interior of trees had been converted into sandstone or carbonate of lime, it would penetrate the bark; or, if the bark had perished, occupy its place, and encase the petrifaction in a stratum of coal, and thus produce those vegetable forms which coal-fields display. These forms may appear to be of a species "*now unknown upon the surface of the earth,*" perhaps on account of the imperfect moulds in which they were cast, or owing to the nature of the vacant spaces into which the bitumen had forced an entrance. And as bitumen, with additional carbon or charcoal, forms mineral coal, we may thus account for the fossils of coal more simply and more satisfactorily than by discrepant theories.

Let us suppose coal a mineral, and the fossils of the carboniferous group as vegetables converted into coal by connexion with true coal, or bitumen in some of its various forms, in a way analogous to that by which wood is petrified; then, the difficulties hitherto involved in the theory of coal will be removed; the endless contradictions which beset geological opinions will disappear; and a simple, natural hypothesis will be introduced, divested of every extravagant speculation, and reconcileable with the obvious meaning of Scripture.

But there are other considerations to corroborate the opinion that coal is not of vegetable origin. There are no coal-beds in Italy, where vegetables must have been most luxuriant. Wood, in becoming coal, is said to lose " most of its oxygen and some of its hydrogen," yet, strange, that after this loss, many species of coal contain more gas than an equal weight of any kind of wood in existence. If the matter which constitutes the rock incumbent on the " delicate foliage and bending branches" of the Bohemian coal-mine, had been deposited from water, the vegetables should have been buried in the rock, and not simply attached to it, as Dr. Buckland states.

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* London Encyclopædia, vol. v, p. 492.

Lyell alludes to a deposit of coal from a lake, though no vestige is left of the lake, nor of the island in which, he says, the lake existed, no, nor even of the sea which contained the island.* A theory supported by such assertions, or rather on such speculations, cannot have truth, reason, or probability for its basis.

Phillips, in his observations on coal, asserts that " the atmosphere might, in those early periods, have an unusual dose of carbonic acid gas;" but he asks, " what proof have we of the globe being tenanted by terrestrial animals ?"† There is proof that the earth was inhabited by animals at as early a period as that in which it was covered with vegetables, and, consequently, before any coal could have been formed from vegetables. We quote from Dr. Buckland in proof of this. " As far as organic remains are concerned," he says, " they go to show the origin of plants and animals to be contemporaneous, and that *no evidence exists to prove that any creation of vegetables preceded that of animals*."‡ But lest it should be suspected that Dr. Buckland alludes to marine, and not to terrestrial animals, we transcribe the following passage from the geological lectures of Professor Ansted : " During this time, many animals of low origin were discovered in connexion with some of a higher organization ; but there were scarcely any fishes, which was an important fact, for they were not discovered till towards the close of this period."§ If there were scarcely any fishes, the period must have been very remote, indeed, and the animals of high organization must have been terrestrial, and, therefore, such as breathed by lungs, to which " an unusual dose of carbonic acid gas" would have proved rather injurious. There is, therefore, proof that no considerable deposit of vegetables could have been made anterior to the existence of terrestrial animals, and, consequently, that no extraordinary amount of carbonic acid existed, to promote, in any unusual manner, the growth of any former race of vegetables.

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* See his theory of coal-formation.

† Geology, p. 163.

‡ Geology, vol. i, p. 18.

§ Geological lectures delivered in Cork, June, 1846.

Pure atmospheric air best suits the animal constitution; vegetables thrive best in an impure atmosphere. Animals consume oxygen in respiration, and exhale carbonic acid; vegetables, on the other hand, imbibe carbonic acid, and give out oxygen. Thus, these two kingdoms stand in opposite relation to each other, one supplying or contributing to supply what is essential to the existence of the other. When vegetables imbibe carbonic acid, they possess the power of separating the carbon, and of expelling the oxygen. In this way, the greater part, if not all the carbon of plants is supplied.

On this subject the celebrated Liebeg observes, that the immense quantity of carbon necessary to produce the timber of those great German forests, which are so frequently cut down to supply fuel to the inhabitants, could not have been given by the soil; for those forest-grounds get no manure, are not cultivated, and yet, new forests soon spring up in place of the former. The same may be observed of bogs, whose surfaces grow thirty or forty feet high, and are almost wholly composed of vegetable matter; the roots and decayed produce of the former year constituting new beds, in which the succeeding year's growth takes root and flourishes, and this with scarcely any communication with earthy soil. These bogs are not manured, no carbon is supplied to the soil, and yet the vegetables are produced. Whence is all the carbon derived?—Evidently from the atmosphere. But whence does the atmosphere receive the vast amount required by the vegetable world? The respiration of animals, the decay of animal and vegetable substances, combustion, exhalations from coal-mines, quarries, &c., seem the principal sources.

The vital power of plants in the assimilation of the simple elements to their own substances, is a subject of admiration. We cannot, by any chemical process, effect what every blade of grass, every leaf of the vegetable creation, effects without any seeming effort. They *directly* decompose air, water, acids, &c., and we can only decompose some of them, and that but *indirectly* and imperfectly. By no chemical process can we effect what the plant does when light shines upon it. It separates the carbon, sets free the oxygen, converts the nitrogen of the air, and the hydrogen of the water, to its own use; in a word, it acts the part of a perfect chemist, containing in itself a laboratory which no art can rival.

The carbonic acid of the atmosphere amounts by weight to ·05 per cent of the whole mass, or to the $\frac{1}{2000}$th part of the entire. The height of the atmosphere is about fifty miles. By the most recent and most accurate experiments, it appears that about $\frac{1}{30}$th of the whole is below the level of 1000 feet; that, at the elevation of 10,600 feet, one-third of the atmosphere is passed through; and half, at the elevation of 18,000 feet.

If the density of the air at the level of the sea be represented by unity, at the height of seven miles it will be but $\frac{1}{4}$; at fourteen miles, $\frac{1}{16}$; at twenty-one miles, $\frac{1}{64}$, &c., diminishing in density according to the terms of a geometrical series, as the altitude increases according to the terms of an arithmetical progression, whose common difference is seven miles. From these data it will follow, that the whole mass of the atmosphere will be fairly estimated by a volume of air 28,000 feet high, and of a uniform density, equal to that at the level of the sea. The number of cubic miles in such a mass would be, very nearly, 1050 millions. The two-thousandth part of this would be 525,000 cubic miles; hence, the weight of the carbonic acid of the atmosphere is equal to the weight of 525,000 cubic miles of atmospheric air. But as the specific gravity of carbonic acid is 1½ times that of atmospheric air, 350,000 cubic miles of the former weigh as much as 525,000 of the latter.

A hundred cubic inches of oxygen weigh 33·9153 grains, and 100 cubic inches of carbonic acid weigh 46·5973 grains;* their difference, 12·6820 grains, is the weight of carbon that unites with 100 cubic inches of oxygen, or that exists in 100 cubic inches of carbonic acid. A cubic foot of carbonic acid contains 219·14496 grains; a cubic yard 5916·91392 grains; and, counting 7,000 grains to a pound avoirdupois, a cubic mile contains 2,057,250 tons weight.

The carbonic acid of the atmosphere being 350,000 cubic miles, and each cubic mile containing 2,057,250 tons of carbon, the whole amount of carbon in the atmosphere may be rated at 720,037,500,000 tons, or in round numbers, seven hundred and twenty thousand millions of tons.

The truth of this estimate may be further shown by the following method of calculation: the pressure of the atmosphere upon a square inch is 15 lb, and upon a square foot 2160 lbs, or the $\frac{27}{28}$ part of a ton. A square mile contains 27,878,400 square feet, and every 28 sq. feet sustain a pressure of 27 tons; consequently, the atmospheric pressure on a square mile is 26,882,743 tons; and taking the surface of the earth at 196,739,792 sq. smiles, the total pressure of the atmosphere would be 5,288,905,266,209,456 tons, the $\frac{1}{2000}$th part of this, viz., 2,644,452,633,104 tons would be the weight of the carbonic acid of the atmosphere. But as the whole weight of any given amount of carbonic acid is to the amount of carbon which it contains, as 46·5973 : : 12·6820, or, as 1 : ·272, consequently, the amount of carbon in the atmosphere will be 2,644,452,633,104 × ·272 equal 719,291,116,204, which is nearly the same as above. Whence did the atmosphere derive all this carbon? Some imagine the atmosphere to be the source of carbonic acid, at least of all that had originally existed in the gaseous form; others, that carbonic acid is derived from the mineral world, and added to the atmosphere, as portions have been of many other substances which seem not to have been at first contained in that vast reservoir. Liebeg is favourable to the first opinion; Dumas supports the second; and the geological theory of coal is opposed to both.

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* Donovan's Chemistry.

If we suppose the atmosphere, at its creation, to have been the source of carbonic acid, the vegetable kingdom must have been thence supplied, and in that case all the carbon now contained in the coal-formation, previously existed in the atmosphere; consequently, the atmosphere held formerly a far greater quantity of carbonic acid than it does at present. The carbon now existing in the coal-fields both of the Old and New World being held in solution in the atmosphere, would render that vast aërial ocean totally unfit for the existence of animals breathing by lungs;* but as no geological evidence exists to prove that any creation of vegetables preceded that of animals, it follows that coal could not have been a vegetable production in the case supposed.

The other alternative is still less favourable to the geological theory of coal. If the atmosphere at first consisted only of oxygen and nitrogen in due proportions, whence came all the carbon? If coal had not then existed, we can conceive no state of things competent to supply the carbon of the coal-formation and the surplus quantity now existing in the atmosphere. Besides, Lyell will admit of no series of " ancient causes differing from modern ones," and without supposing some extraordinary set of ancient causes which no longer exist, and which have no parallel in modern times, we could not well conceive how the carbon of the atmosphere had been supplied.

Instead, therefore, of the atmosphere containing a vast dose of carbonic acid at first, we can only suppose a gradual accession of this substance; and thus vegetables would have been the very reverse of what they are represented by geologists; while animals, on the other hand, would have been numerous and healthy. Besides, if the carbon of the atmosphere was thus supplied, no portion of the mineral world is so calculated to furnish the principal amount required, as the coal-strata; so that in whatever light we view this subject, the obvious inference is, that coal is not a vegetable production, but truly a mineral.

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* Though this inference is just in the supposed case, it is contrary to fact; for animals at first were very numerous, as well as remarkable for size and strength; and this circumstance affords an additional proof that coal is not of vegetable origin.

Limestone and chalk contain carbonic acid, but if they be animal productions, as geologists affirm, they could have supplied none of this gas to the atmosphere, vegetables and animals being co-eval. But, if the mineral world supplied carbon to the atmosphere, the natural impression would be, that coal, limestone, and chalk contributed the principal supply, and hence, that coal is no more a vegetable production than chalk and limestone are animal formations.

Adopting Lyell's idea, that " no ancient causes differ from modern ones," and supposing the atmosphere to have been created as it now exists; that coal, chalk, and limestone are true minerals; and that the animal and mineral worlds restore to the atmosphere the carbon consumed by the vegetable creation; we avoid the anomalous theories of geologists, and substitute a simple and natural hypothesis, which accords with Scripture, common sense, and the observed phenomena of nature.

To sum up our account of coal, we will place on one side of the balance (1) the woody structure of some species of coal; (2) the leaves, branches, trunks, &c. of *no existing order* of vegetables found in some coal mines; (3) the *similarity* of the *materials* which constitute wood and coal; (4) the *lignite* or brown coal, which seems to show " an accurate view of the course of alteration," by which wood becomes coal; and (5), *which is the most important* item in this side of the scale, the names of the many eminent geologists who maintain this opinion, as Lyell, Buckland, Phillips, Kane, M'Culloch, &c.

Against this formidable array of evidence we place the following facts, and leave the reader to determine which side of the balance preponderates. 1, Pitchcoal occurs in the shape of branches of trees, although it *has not* the woody structure. Had this been wood at any previous period, how did it lose the woody structure, while coal, which has not the external form of wood, exhibits that woody structure? 2, The numerous and singular veins into which some coal-beds branch out, could not possibly have arisen from any arrangement of vegetable matter brought together by water, according to the geological theory. 3, A very fine species of coal is found mixed up with the common coal in several mines in England. The fine coal runs in veins through the common coal. Is this fine coal composed of a peculiar species of wood? If so, how has it been thus arranged? If composed of the same description of vegetable matter, how has it been subjected to a different process in the alteration it has undergone? 4, Culm and the shale with which it is associated, undergo similar changes by exposure to the atmosphere. How can this be explained if shale be indurated clay, and culm a vegetable production? 5, Coal, formed without enormous pressure, could not be heavier than the wood which produced it. Parting with its oxygen and hydrogen will not increase its specific gravity. Charcoal becomes much lighter than wood, because the gases are dissipated, and a similar process could not make coal heavier. 6, Wood, subjected to great pressure, could not retain its delicate foliage, bending branches, graceful festoons, &c. &c. 7, Coal contains more gas than an equal weight of wood, though by the geological theory the wood which formed the coal parted with most of its gases. This is an evident absurdity. 8, The geological theory explains not how coal-beds could have been formed under the bed of the Shannon and other great rivers, under the sea, &c. Nor how, consistently with the natural order of things, there could have been three beds in the Tipperary coal-field, six in the Munster-field; eight in the Kilkenny; forty in the Newcastle, &c. 9, If, as geologists say, coal is anthracitous and bituminous according to its age, why are not the lower beds of bituminous coal-fields, anthracitous, and the upper beds of anthracitous coal-fields, bituminous, as the interposing strata supply geological proofs to show that the lower beds in one must be as old as the upper beds in the other? Nay, the intervening beds of sandstone, ironstone, limestone, shiver, &c., would go to prove that bituminous and anthracitous coal-fields are co-eval. 10, Beds of the same species of coal alternate with different mineral strata; proving, if the theory of coal-formation be true, that water which deposits ironstone, is incapable of affecting vegetable matter differently from a stratum of water which deposits sandstone or limestone; though it will be found by experiment, that water holding iron in solution will affect vegetables very differently from water holding carbonate of lime or silica in solution. (11), Gold, silver, iron, &c., are found in coal arranged as in other mines, without the appearance of having been accidentally brought thither. How can this be accounted for if coal be of vegetable origin, as all the metals are simple bodies, and must have been created along with the other elementary substances? (12), The geological theory affords no satisfactory explanation, as to the manner in which the coal-beds of Peru could have been formed at the elevation of 14,700 feet above the level of the sea; nor how coal and cinnabar exist together in the silicious limestone of the Andes; how iron alternates with the coal-beds of Virginia, &c. (13), Similarity, or even identity of structure does not demonstrate identity of origin. (14), Were wood capable of becoming coal, without the agency of pre-existing coal, no reason has been assigned why such a change may not be effected by heat, pressure, moisture, &c., in a hundred or a thousand years. Why have not the trees of the primeval world, like modern trees, undergone decay? What properties did primeval wood possess which existing wood does not? And what causes operated then which exist no longer? (15), The quantity of vegetables necessary to form existing coal-fields could not have been produced upon the spaces they now occupy, nor so arranged by any series of natural causes as to form the curious veins to be met with in almost every coal-field. (16), The coal-beds, and layers of rock which cover them, could never possibly present *smooth* surfaces to each other, had the incumbent beds been gradual deposits from water, upon heaps of prostrate vegetables, as the geological theory specifies. (17), Plumbago, being crystallized carbon, has as just a claim as culm to a vegetable origin; and diamond, being pure carbon, may be fairly referred to the same parent. Thus would the theories of geologists involve us in absurdities. (18), All attempts to form artificial coal have hitherto been unsuccessful; though some chemists pretend to know the course of alteration which wood undergoes in becoming coal. (19), It is as rational to suppose that some species of coal may resemble wood, though not really wood, as to suppose that wood brought into a valley or lake by water could assume the forms which coal-veins exhibit. We do not, therefore, assume more in adopting the former hypothesis, than geologists do in assuming the latter. (20), Whether we suppose carbonic acid derived from the mineral world, or to have been created a portion of the atmosphere, we cannot admit the vegetable origin of coal without overturning those natural laws by which the material world is governed. (21), The effects produced on coal by heat, especially when under enormous pressure, and not in contact with the atmosphere; the changes which liquid bitumen undergoes, the forms it may assume in passing through the strata of coal-fields; the effects it is capable of producing on vegetables when subjected to great pressure; its capability of occupying the place of decayed vegetables, and of filling the moulds or impressions which they may have left in shale; of encasing masses of sandstone or carbonate of lime in a coating of coal, as it were of bark, and giving them the forms of trunks or branches of trees;*—all these will account for the phenomena of coal without supposing it to be of vegetable origin. (22), Coal under peculiar circumstances may assume vegetable forms, as well as the many other minerals which are known to do so; and hence, the fossil-flora of coal does not demonstrate the vegetable origin of that mineral. Lastly, coal is one of the links which unite the vegetable and mineral kingdoms; many of the qualities of each class should, therefore, exist in the common link by which they are united.

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* The bark which surrounds the vertical and oblique trunks of coal-mines, resembles the laminæ in the brown coal-formation near Bonn, and in the Switerbrand of Ireland, which are as thin as paper, and which no vegetable matter could have formed, according to the geological theory.

If we admit that layers of leaves subjected to great pressure could have formed these laminæ, what shall we say has become of the fruits, flowers, seeds, branches, &c.? By what magic could the leaves alone have been selected and arranged? and why should they be so different in nature from all other leaves which perish so readily in water? Prof. Lindley states that "having immersed in a tank of fresh water during more than two years, 177 species of plants, including representatives of all those which are either constantly present in coal-measures, or universally absent, he found that the *leaves and bark* of most dicotyledonous plants are wholly decomposed in two years;—that monocotyledons are more capable of resisting the action of water, particularly palms and scilanuneus plants, but that grasses and sedges perish;—that fungi, mosses, and all the lowest forms disappear;—that ferns have a great power of resisting water if gathered in a green state.

Ferns, sigillaria, lepidodendra, calamites, stigmariæ, and coniferous plants, are the vegetable fossils of the coal-measures.

CHAPTER XIV.

How far foot-prints in sandstone prove the antiquity of the earth's crust—Structure and habits of animals deduced from foot-prints—Impressions by rain-drops—Objections—Landscape-stones—Slate-quarries near Angers—Forms of marine animals in slate—Dendritic pyrites in slate—Varieties of rock—Minerals in sandstone—Extended inductions of geologists—Absence of fossils in quarries where foot-prints abound—Rapid formation of sandstone—Human foot-prints in secondary limestone and iron—Fossils of ancient animals—Human fossils and works of art—Antiquity of ancient animals and works of art contrasted.

The numerous impressions discovered in sandstone, supposed to be the foot-prints of ancient and unknown animals, are triumphantly cited by geologists as indubitable proofs of the antiquity of the earth, and of the former existence of animals which have no analogous species amongst those now existing. Such marks, and those by which the midnight robber is discovered, or the modern animal hunted down, are deemed equally certain indications of the facts to which they refer. If those impressions are really the foot-prints of animals, the antiquity of the strata in which they exist can scarcely be doubted.

Dr. Buckland treats this subject at great length in his work on geology, and his opinion is followed by almost every modern geologist. Professor Ansted informs his audience, that from " the appearance of certain marks, they could almost derive some idea of the constitution of the body. In one instance they had impressions of an animal, the marks of whose fore-feet were much closer respectively than those of the hinder extremities; and of course the conclusion was, that the hind-legs were considerably longer. By great good fortune, bones of some reptiles were found in Cheshire, including the jaws, the hinder extremities, and portions of the fore-extremities. This animal seemed to be of the crocodile species, but so disproportioned were the legs, that while the fore-extremities might belong to an animal six feet long, the hinder might reasonably be those of an animal eighteen feet in length. Here, then, from the bones discovered, they had an animal of a peculiar frog-like structure, partaking of the character of a crocodile, but which appeared to be as large as a rhinoceros,—an animal capable of making an impression with its foot of upwards of two feet in length."

The learned Professor at first contents himself with saying, that *some idea* may be derived of the animal in question; next, he describes its shape and size, and of course could feel no difficulty in determining its nature and habits. Such reckless assertions avail little to advance the cause he advocates.

He tells of " another animal discovered in this series, which displayed the most wonderful combination. Of the feet of this animal they knew but little; though the impressions in the Cheshire quarry were those of an animal like a bird, having three toes, and a little mark indicating the appearance of that curious spur which birds possess. In the beginning of last year, (1845), some bones were brought from South Africa, exhibiting an appearance something like the animal alluded to. It was not known to what age they might be referred, but from analogy of structure, they had been referred to the same period as the former animal."*

This is truly a wonderful animal, of whose feet we know but little, yet, by this little, philosophers are able to refer it to analogous species in South Africa, and thence infer that England and South Africa once enjoyed equal degrees of temperature.

But this is not all.—" In a quarry near Liverpool," he observes, " which is composed of a description of soft clay, they found not only these particular impressions that appeared to be the foot-prints of the animal when it walked upon the sea-shore; but also a number of round marks, which had been proved to be the impressions of rain-drops that fell *thousands upon thousands of years since*, and so distinctly preserved, that they could actually tell the point from which the wind blew, when the rain fell that created these impressions."

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* Geological Lectures, delivered in Cork, June, 1846.

These impressions described by Professor Ansted are similar to those noticed by other geologists; nor are the inferences drawn by the learned lecturer more extravagant than those of other philosophers. There are, however, other facts calculated to refute those idle theories, and to redeem geology from the ridicule of such romancing.

Let it be borne in mind that these imaginary foot-prints are never found on the exterior of sandstone-rocks. No; these marks only appear when the stratified rocks are separated. They are found under layers of sandstone, impressed on the underlying surface. Now, had these been made by animals, are we to suppose that none could have been preserved, but such as had been covered by other layers? Additional layers would be far more likely to obliterate than to preserve impressions on sand by foot-prints or by rain-drops. If the surfaces on which the impressions appear, were suddenly solidified, *ere* a storm or shower of rain could come to efface them, then we should expect to find such marks or foot-prints on the exterior surface of several rocks.

But if, as Dr. Buckland observes, "the only condition of such preservation being, that they should become covered with a further deposit of earthy matter, before they were obliterated by any succeeding agitations of the water," then they should have been covered before the mass was hardened to stone; and thus, both layers would become so identified, that their subsequent separation would effectually efface such marks. So that in whatever point we view the case, the result is unfavourable to the geological inference.

The justice of these remarks may be tested by experiment. Let Roman cement or any similar preparation, be saturated with water, let impressions be then made, and the stratum allowed to acquire any degree of hardness before a second deposit of the same matter, similarly prepared, be made upon it. Let the whole mass be then allowed to harden, and if both the parts can then be separated without obliterating the impressions, our objections will be nugatory, and the geological inference confirmed.

The marks in a sandstone quarry, on the borders of the Connecticut river, have excited much attention. Professor Hitchcock drew up an interesting memoir upon this subject. The first specimens, he says, were in square slabs, taken from a quarry of flagstones, presenting four distinct and perfect tracks of a large bird; the lower stone bearing the depression, and the upper stone the impression, precisely as they would appear if formed in soft mud, and suddenly hardened. Other specimens were discovered, some in red shale, some in gray micaceous sandstone, and others in hard sandstone, composed of clay and sand. The strata in these quarries lie in various degrees of inclination, and the foot-marks vary in size, from very small to incredibly large. Some were supposed, by the learned Professor, to be those of an animal with two feet, each provided with three toes; in some instances a fourth toe projected behind, in the manner of a spur; and in others, all the toes were in front. The shape of the toes varied; some were straight and tapering, some crooked, and others round and blunt. The bird to which the largest belonged, had evidently been of greater size and weight; for, on cleaving some specimens of the tracks crosswise, the clay was found depressed to a depth of three or four inches. By a careful separation of the slabs, other specimens were obtained in relief, from which the structure of the foot could be better determined than by the cavities. In one instance ten tracks were found following each other in regular succession. But sometimes different species of animals, and different individuals, have crossed each other's tracks so often, that all is confusion, and the whole surface appears to have been trodden over. The earliest specimens were classed as thick-toed, and slender-toed, and described under the general name of *ornithichnites*, or stony bird-tracks. The largest was supposed to have belonged to a stupendous bird, as it measured fifteen inches in length, with an addition of two inches for a claw. The prodigious size of the bird was inferred from the length of its steps; the ordinary walking stride was four feet, which might be increased on occasion to six. Another species, like the former, was three-toed, with a foot from fifteen to sixteen inches long, and a hinder toe or spur eight or nine inches long. The ordinary step was six feet, and the bird was so heavy as to sink deeply into the mud at every stride. "Indeed," says Professor Hitchcock, "I hesitate not to say, that the impression made on the mud appears to have been almost as deep, indicating a pressure almost as great as if an elephant had passed over it."

Similar fossil foot-marks have also been met with in England, Scotland, Saxony, and various parts of Europe, as well as in many parts of the American continent; and of course the quarries in which they exist, must have undergone changes, similar to those which geologists suppose to have occurred in the valley of Connecticut. There we must "imagine a large estuary in remote times, and these foot-marks to have been made on the borders of a shallow expanse of water. The larger birds would sometimes wade into the water in search of food; and supposing the surface to remain placid, layer after layer of soft mud would be quietly deposited in the deep-sunk tracks which they left, until the whole was filled up, yet without obliterating the impression of the birds' feet. In some instances a concreting process has taken place, so that on separating the layers of stone, a perfect *fac-simile* of the foot is obtained. The very perfection of the specimens shows that they cannot have been exposed to atmospheric influences, such as would have been the case had they been formed on mud left dry by the tide. Subsequently to the filling up of the tracks, they have been sunk to a depth of some hundreds of feet, and hardened into stone.

Since that period, and while the oolitic, cretaceous, and tertiary groups of rocks were being deposited, they have been upheaved to the position in which they are now found."*

"That the *ornithichnites giganteus* and *ornithichnites ingeus* were double the height of the African ostrich, and consequently eight times its weight and size; that they rivalled the camelopard in height, and would be fitting companions for the enormous quadrupeds which existed contemporaneously on earth," are the inferences drawn by geologists from those foot-prints. That such monsters existed at any period is very improbable, and that they should frequent the same localities with other *species whose foot was but one inch long*, and whose stride was but three inches, is yet more unlikely. But granting the existence of these monster birds, the theory of the formation of their foot-prints cannot be reconciled with the ordinary course of events. In the first place, several assumptions are made without any proof, as that the surface remained placid, while the layers of soft mud were being deposited; that the deep-sunk tracks were filled up, yet without obliterating the impression of the birds; that in some instances a concreting process had taken place; that the impressions were not exposed to atmospheric influences; that the whole space had been sunk hundreds of feet, and subsequently raised to the position they now occupy. All these suppositions are liable to serious objections. The weight of the bird cannot be proved by the depth of the tracks, as the softness of the mud would offer an equally satisfactory solution for this appearance. Our coasts and estuaries at present are daily crowded with myriads of sea-fowl, yet we find every day's impressions obliterated or filled up by the following tide; nor can we perceive any reason for supposing that any foot-prints could be discovered, were these localities turned into stone by any geological process. Though Lyell advocates this theory, he does so in direct opposition to his own principle, viz., that there were no ancient causes in operation, different from those now existing.

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* Chambers' Edinburgh Journal, vol. viii, No. 203, p. 330.

Had these impressions been really produced as geologists imagine, it is obvious that every layer of rock in these quarries where these foot-marks are found, should exhibit similar marks even to an unknown depth; for we must suppose the causes by which any set of marks were produced, to have been in operation for a long period. Birds, in former times, must have been confined to certain localities for generations, as well as they are at present; they had to visit the shores daily in search of food, and every new tide probably filled the impressions of the former day as they do now. Otherwise, ancient causes would have been widely different from modern ones. Now, the quarries most famous for these impressions afford no facts to bear out this just and rational inference; consequently, there is reason to doubt the conclusions at which geologists have arrived about these imaginary foot-prints. Myriads of birds frequent our shores, and sandstone and limestone are being formed; yet in no one instance can we discover any tracks, which can be referred to existing species. It is, indeed, very strange that extinct species are the only ones which have left such traces behind them; as if to leave such marks it was necessary to become extinct. But when we come to that part of the theory which supposes a subsidence of the estuary to a depth of some hundreds of feet, that the strata may be hardened to stone by the superincumbent pressure, we are really at a loss to conceive how the effects spoken of could have resulted from such a cause; how layers of soft mud and sand, reposing upon each other, and subjected to enormous pressure, could yet, instead of being compressed into one solid mass, be preserved in some degree distinct, and perfect *fac-similes* of foot-prints be obtained from the separated masses. If the sand and clay, of which these rocks are believed to be composed, were subjected to enormous pressure, then the marks are not foot-prints; for foot-prints could not have been preserved during the process of consolidation, at least so as to reappear in the perfect forms in those specimens mentioned above.

But to what are those marks to be attributed, which in their form and regularity so much resemble the foot-prints of animals? Before answering this question, let us make some preliminary observations.

Lately, in repairing a road in the vicinity of Cork, a very singular phenomenon was discovered. When rocks of hard stone were separated by the force of gunpowder, or by the iron wedges of the quarrymen, the surface of the parted layers exhibited the most curious forms of leaves, branches, plants, &c. Passengers from whom the workmen expected the smallest gratuity, were liberally supplied with specimens. The landscape-stones, as they were locally called, excited the attention of the curious, but the slightest glance at the figures would suffice to convince the observer that they are not the impressions of vegetables, however much they resemble them, but produced by some colouring matter, or some difference of quality in the material of the rock, which the colour alone could make sensible. This opinion is demonstrated by the fact, that the same figures appear on both sides of the Bristol landscape-stone when pieces are polished. Nay, the coloured part may be perceived to penetrate through the stone, and consequently, could not have been produced by any application of vegetables.

In the slate-quarries of Normandy, the most singular figures occur between some of the laminæ. "It is between these leaves that there are frequently found vestiges of marine animals, and particularly pyritous impressions of *pous de mer ;* also of small cheviettes, and a species of crab, of which the body is about a foot in breadth, and fourteen or fifteen inches in length, the tail having nine or ten rings. The shrimps are sometimes so numerous, that forty have been counted on a slate of a foot square. None of the animals resemble any known existing species. But the most remarkable circumstance in these impressions, particularly in the large crabs, is, that though there be no sign of the body having been crushed, yet it can scarcely be said to have any thickness whatever. They rather resemble engravings than figures in relievo. A series of these leaves may be compared to a set of books placed upon shelves; and the impressions of crabs and other marine animals, to engraved plates in the volumes. They do not, in fact, occupy more thickness. It is equally difficult to conceive how the bodies of these animals, though perfectly defined, could be reduced to a simple surface without thickness."*

We cannot imagine these impressions were made by the bodies of the actual animals. The bodies exhibit no sign of having been crushed, and yet, they actually should have been crushed! They are simple surfaces, and yet, they are the remains of animals! They are perfectly defined bodies, and yet, they have no thickness! Who could believe such absurdities? Had the bodies been actually crushed, they *should* have some thickness, but *could not* impress upon the slate the representations of the living species. Though a crushed animal may impress the form of its mangled remains, it could not form the perfectly-defined outline of the living animal.

As the fat of the viper supplies the best antidote for its poison, so the facts of geology often furnish the strongest arguments against the false inferences drawn from them. *Had* the impressions in those slate-quarries been like any existing species of marine animals, or *had* the marks on the sandstones of England or Scotland been like the foot-prints of living animals, our difficulty in accounting for them would have been increased; but, fortunately, we are freed from this embarrassment by the fact, that neither the marks of the marine animals in the slate-quarries of Normandy, nor the marks which resemble foot-prints, are like those of any existing species of animals.

Marks of this kind are so common, and assume such varieties of form, that they must sometimes represent objects with which we are familiar. Nay, the human mind is prone to group together the most dissimilar objects, and form them into figures; and hence, human faces and human figures, without limit,—animals, trees, &c., are seen by those who pore over a fire, the clouds, variegated marble, &c.; but, like the impressions on stone, these forms are unlike any existing beings. The foot-prints in sandstone are not like those of any living animal, because they were never impressed by living animals; nor were the likenesses of marine animals in the quarries of Normandy ever produced by living species. But geologists, anxious to prove the antiquity of the earth's crust, have wrested every circumstance they could to this end.

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* Encyclopædia, vol. xx, p. 435.

The slates in these quarries present "beautiful dendritical pyrites, more than a foot in extent. The pyrites are sometimes in small grains, disseminated, like dust, upon the surface of the slates, where may also be observed many little stars of selenite."

"These arborescent appearances resemble the figures pourtrayed on the landscape-stones, and they are produced by the dissemination of the pyrites over the surface of the slate. But they are not exclusively leaves and branches; they also resemble stars, and probably many other objects." Here we are told how these forms are produced by means of pyrites, and it is easy to conceive how a mixed rock may exhibit all these figures.

Perhaps the combinations into which the various substances enter, in the composition of rocks, are more complicated than in the production of organic bodies. Rocks the most dissimilar, pass into each other by innumerable variations; and even in the same families, the gradations are countless. Slates and sandstones are as varied as other classes of rocks; clay-slate gradually passes into mica-slate, and frequently contains grains of quartz, and crystals of felspar, schorl, tourmaline, garnet, hornblende, &c. Pyrites of iron, copper, and arsenic, and a variety of minerals, are found in the clay-slate-formation. Alum-slate, drawing-slate, red-slate, blue-slate, talc-slate, chlorite-slate, green-slate, gray-slate, &c., are among the varieties of this rock.

Sandstone is composed of grains of quartz or some other silicious stone, cemented by some basis, as, clay, lime, marl, iron, &c., and is named argillaceous, silicious, calcareous, marly, &c. Some kinds contain cobalt, and copper often impregnates the old red sandstone. Roestone and sandstone-slate often occur in beds of this formation. Sandstone is green, brown, red, white, according to the nature of the substance which forms its base. All these rocks are materially changed by exposure to air. Deep in the earth, they are saturated by water impregnated with minerals, which penetrating through the stratifications and laminæ, and acting differently on the different substances of the rock, produce different figures by the slightest changes of tint; and thus the dendritic and animal appearances on the slates and landscape-stones are formed.

The impressions on sandstones arise from the fact of having the incumbent layer contain portions of matter, different, in some respects, from the rest of the rock. This matter may have been arranged in peculiar forms, just as the selenite of the slate has the form of stars. Should it be a little harder or even a little softer than the rest of the stratum; and should it adhere more firmly to one layer than to the other, the marks or impressions will be evident when the layers are separated. These marks may be impressed upon one stratum, and show, in relief, upon the other. Spiral impressions of this nature, resembling worms, small reptiles, &c., are common on the flagged foot-paths of many of our towns.

Something similar is seen when pine-wood is formed into roofing laths. The knots of one layer impress their forms on the next, and so the marks on sandstone have been produced. The similarity of these marks, and their regular distances asunder, circumstances which enforce the idea of their being animal foot-prints, are not more remarkable than the star-like and dendritic impressions already referred to. The marks, in many instances, do resemble the foot-prints of animals, but there are also many cases in which the marks cannot be referred to such a cause.

In this case, as in so many others, geologists extend their inductions beyond just limits. Impressions appear which seem made by animals having relation, in some respects, to living forms. Other impressions occur which no one would refer to animals, had not the former marks existed. Then, by the geological mode of inductive reasoning, peculiar to the science and not tolerated in any other, strange monsters are conjured up, whose foot-prints might correspond with the observed marks; and these are the unknown animals which geological discoveries sometimes reveal. The impressions shown in Dr. Buckland's geology, may be more justly referred to the *hand-prints* of a peasant boy, than to the foot-prints of an unknown animal; such was the opinion of the workmen by whom these marks were first discovered, and such, no doubt, would be the inference drawn by philosophers, were the earth's antiquity the obvious conclusion to be thence deduced.

It is singular, that the quarries where these supposed foot-prints abound, contain no fossils of these extraordinary animals. This could scarcely be the fact had such animals really existed.

But, granting that such animals *did* exist, and that the impressions in sandstone are their identical foot-prints,—concessions which we are not bound to make—the indefinite age of the earth cannot even, from such data, be demonstrated. For strata are rapidly converted into stone, under different circumstances. The limestone-formation of Guadaloupe is supposed, by General Ernouf, to have been formed since 1710, or thereabouts.

Meteoric stones have fallen in all ages, and, consequently, must have been instantaneously formed in the atmosphere; and can it be a matter of surprise if similar causes could produce similar effects, on a more extensive scale, in the bowels of the earth, without requiring endless ages? Masses of iron are said to have fallen from the heavens; and shall thousands of years be deemed insufficient to produce a mass of sandstone or conglomerate? The rapid formation of meteoric substances will convey a just idea of the rapid formation of rock under favourable circumstances.

Sandstones and conglomerates are rapidly formed whereever the cementing matter is abundant. Masses of sand seem to have been cemented at Dunmore in the County Waterford, and conglomerates are widely diffused throughout that county. Sand and pebbles were so firmly cemented by the iron of water-pipes in Cork as to constitute vast blocks of sandstone and conglomerate, although the pipes were in use but for a few years. A singular stone found near Tramore is now in a private museum in Waterford. This stone on being broken was found to contain a small padlock. The smiths who examined this curious production, affirmed that locks of the same construction had been in common use about forty or fifty years previously; an evident proof that the stone in question required neither myriads nor millions of years for its formation.

Roman cement, plaster-of-paris, and many other calcareous substances, become hard almost suddenly in contact with water. Fine volcanic sand, charged with twenty per cent of iron and a small quantity of lime, becomes a solid stone in water. The marl deposited at the bottom of Lake Superior, if dried, becomes hard like a stone. But the action of heat at various depths in the earth is probably the most powerful cause in hardening sedimentary matter. A few years will suffice for the growth of a forest. The vegetable world is renovated in a few months; and how can we imagine indefinite ages necessary to form a stratum of rock?

Impressions on stone are referred to remote epochs, because unlike any which existing beings could have formed; but when impressions occur which have been made by man, or by known animals, antiquity is set aside, and a new theory devised to explain the phenomenon. Now, as man's origin cannot be known by geology, it is unjust to make it the term whence to mark geological epochs. Human foot-prints have been found in limestone of the secondary series. Here is geological proof that secondary rocks were formed within the historic period, or that man's existence on earth was anterior to that formation. Which alternative will geologists choose?

" A mass of iron was found in South America, in the district of St. Jago del Estéro, at a place called Otumpa, in lat. 27° 28′ south. Externally it had the appearance of very compact iron; but internally it was full of cavities, as if the whole had been formerly in a liquid state. I was confirmed in this idea, by observing on the surface of it, the impressions of human feet and hands of a large size, as well as the feet of large birds, which are common in the country. Though these impressions seem very perfect, yet I am persuaded that they are either a *lusus naturæ*, or that impressions of this kind were previously upon the ground, and that the liquid mass of iron falling upon it, received them."*

We do not think modern geologists will coincide with the Spanish commissioner sent to examine this mass, as to the manner in which these impressions were formed on the iron, although there seems no reason to doubt the reality of their existence. The *lusus naturæ* theory they will not admit, as it may with equal reason be applied to the sandstone impressions, or to the fossils of the coal-formation. The commissioner ought, however, to have remembered, that had the marks been made on the liquid mass by impressions previously found on the ground, they should appear on the iron in relief.

Had these been impressions of *unknown animals*, they would have been triumphantly cited by geologists as proofs of remote periods, nay, as evidence of the era when animals could impress their marks on liquid iron, and when the state of the earth and of its inhabitants was the very opposite of what it is now. Probably, some philosopher would have used this fact as proving the former liquid state of the earth by fire:—it would have well suited the theory of Buffon and his followers.

But there are other proofs besides foot-prints, of man's claim to antiquity as great as that of any other beings of the organic kingdoms. The skeletons of the mammoth, mastodon, megatherium, and several other ancient animals, are invariably found buried in low, marshy situations, along the banks of rivers, &c. A skeleton of the great mastodon, nearly complete, was dug up on the banks of the Hudson river in 1801. The most perfect skeleton of the megatherium yet found, was discovered on the banks of the river Luxan, near Buenos Ayres; and the remains of the mammoth are abundant along the banks of the Volga, Don, and the other northern rivers of Russia. These are, precisely, the situations in which such remains ought to exist, according to the ordinary course of the present order of things. The following facts will show that such animals have no claim to greater antiquity than those animals called *recent*, or than man himself.

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* London Encyclopædia, vol. xii, p. 177.

A very ancient subterrene town, apparently of Hindoo origin, was discovered in India, in 1833, on digging the Doab canal. Its site is seventeen feet below the present surface of the country. Several coins of silver and copper, and many articles of art, have been found. The city of Ougein, and about eighty other cities of Central India, are said to have been buried beneath a shower of earth. Entire brick walls, pillars of stone, and pieces of wood of extraordinary hardness, besides utensils of various kinds, and ancient coins, are found at fifteen or eighteen feet below the surface. Many coins are also found in the channels cut by the periodical rains. At Pickaway plains on the Ohio, a human skeleton has been found seventeen feet below the surface, in a bed of shells and pebbles deposited by water. At Cincinnati an arrow-head was found ninety feet below the surface; and at Illinois, fragments of antique pottery and jars were found at the depth of eighty feet.*

"Human skeletons, embedded in a solid limestone rock, were found on the shore of Guadaloupe."† In digging a canal, in 1819, at Södertelje, about sixteen miles to the south of Stockholm, to unite Lake Maeler with the Baltic, marine strata, containing fossil-shells of the Baltic species, were passed through. At a depth of about sixty feet, they came down upon what seems to have been a buried fishinghut, constructed of wood in a state of decomposition, which soon crumbled away on exposure to the air. The lowest part, however, which had stood on a level with the sea, was in a more perfect state of preservation. On the floor of this hut was a rude fire-place, consisting of a ring of stones, and within this were cinders of charred wood; on the outside lay boughs of fir, cut as with an axe, with the leaves or needles still attached."*

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* Information for the People, No. 97.

† Buckland's Geology, vol. i, p. 104.

"After some days' travelling in Thakpar, we came to an old deserted city, an imposing and majestic ruin. The castellated ramparts, the towers of observation, the four huge gates, situated at the four cardinal points, were all in a state of preservation. But three fourths of the entire were sunk into the earth and covered over with the green sward. Since the city had been abandoned, the soil had accumulated, and risen to almost the height of the castellations. Here you see neither dilapidations nor ruins, but the form of a beautiful and large city, half buried, and which the herbage folds, as it were, in a funeral shroud. The uneven surface of the earth seems to mark out still the situations of the streets and monuments."†

Formations like that of Guadaloupe are in progress in several parts of the West Indian archipelago. Fragments of vases and other human works have been found in similar rocks in St. Domingo, and near Catania in Sicily. A cannon was drawn from the delta of the Rhone enclosed in calcareous rocks. A sandstone was found round the iron part of a cannon taken out of the sea, near the Downs, in 1776. Many examples are recorded of iron instruments found in the sea near the British coasts, encased by thick coatings of conglomerate.

From these facts it is evident, that as far as situation is concerned, animals reputed *ancient* by geologists, have no juster claim to that distinction than man. The fact of being extinct animals, will not establish their claim to antiquity. We will show further on why several races of animals have disappeared from the face of the earth, the result of mere natural causes.

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* Lyell's Geology, p. 347.

† Annals of the Faith, vol. x, p. 241.

CHAPTER XV.

Every science, and every organized being, constitutes a system—Inferences from imperfect data—Theories of mineral veins—Opinions of Professor Jones—Origin of carbon—Origin of the lias-formation—Speculative notions of Lyell—Successive creations of organized beings—Convulsions in the Paris basin—Strata of Triel—Erratic blocks—Rock-dykes and rock-veins—Production of metals—Objections—Position of metallic ores—Junction of rocks—Bog-iron—Metallic ores in veins—Geological theories form no complete system—Metals, simple substances—Imperfect data upon which the geological theory of strata is based.

We can say of a science what Cuvier says of an organized being, that "every individual forms an entire system of its own, all the parts of which mutually correspond, and concur to produce a certain definite purpose by reciprocal reaction, or by combining towards the same end." In the animal system, "if the viscera are so organized as only to be fitted for the digestion of recent flesh, it is also requisite that the jaws should be so constructed as to fit them for devouring their prey; the claws must be constructed for seizing and tearing it to pieces; the teeth, for cutting and dividing the flesh; the entire system of the limbs or organs of motion, for pursuing and overtaking it; the organs of sense, for discovering it at a distance," &c.

In like manner, if a theory be true, every fact must confirm it; every discovery must tend to establish it; and every other science must accord with it. It must not clash with any truth; must not vary with any new doctrine or opinion; must be founded on unobjectionable principles; must involve no discrepancies; must obtain no contradictory conclusions; but, like every system whose parts harmonize, each fact and circumstance must concur in confirming the whole.

By the application of these principles, the distinguished baron succeeded in classifying the fossil-remains of so many different species of animals, and reconstructing others from imperfect skeletons, and sometimes from single bones.

In those branches of science which all ages and nations have sanctioned, this rule holds good. In the practical departments of geology it is also applicable to as great an extent as could be hoped for in an infant science; but in the inferences from geological facts regarding the origin and cause of existing phenomena, the most manifest absurdities and discrepancies prevail.

When general conclusions are drawn from isolated facts or imperfect data, or when theories are devised to suit particular circumstances, they always clash with other principles or subvert other laws. Philosophers sometimes frame hypotheses to explain certain difficulties, or to establish individual opinion, unmindful of every other consideration. Thus it was with the early geologists:—their extravagant theories were directed to particular objects, and hence, they have long since been consigned to oblivion. Modern philosophers walk in their foot-steps; and their theories vanish like those of their predecessors.

Hutton supposed the matter of mineral veins to have been produced by fusion from below; Werner, by solution from above; Necker ascribed their formation to mere sublimation. But the discovery of strings and branches of metallic substances in solid rock, was sufficient to overturn these speculative opinions. Some imagine electrical currents to have been the agents in transferring the metallic substances to their peculiar repositories; "but as to the vein-fissures having been originally open above or below," remarks Phillips, "and as to the manner of their being filled, these points remain for further consideration."*

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* Geology, vol. ii, p. 153.

These points will, indeed, remain long unsettled, if they are to be accounted for by geological theories; but, if we refer them to the true cause, the evident design of the Creator, the difficulties will all disappear. In the animal and vegetable kingdoms, every individual is admirably adapted to its end, and every member of each individual is wonderfully fitted to discharge the functions assigned it. So it is in the mineral world, every portion is arranged with the selfsame obvious design as appears displayed in the other kingdoms of creation.

Professor R. Jones revives the exploded theory of Buffon, as to the original state of the earth; but he tells not how it came to be "either a mass of fire, or in such a state of incandescence, that life was impossible upon it." In his notice of granite and mica-schist rocks, which are in immediate contact, and in which not the slightest vestige of plant or animal is found, he affirms that no carbon existed at this period. "What was the condition of our planet at this time," he says, "was beyond our power at present adequately to speculate on; but there seemed at least to be one deficiency in the elements required for the support of life; there was no trace of that most extensively diffused element, carbon, having existed at all. That fire existed is indubitable; but it seemed to have been produced by volcanic action, chemical agencies having nothing to do with what we now call burning. There being no proof of carbon existing at that remote period, we could not suppose that animal bodies, having carbon entering so largely into their system, could have been produced till after the existence of that element."*

Professor Jones, in thus advocating the subsequent creation of carbon, admits the distinct creation of elementary substances. Dr. Kane is of a different opinion, and in demonstrating that the elementary substances are in constant rotation, denies the creation of any new matter, or the annihilation of any of the old.†

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* Professor Jones' Palæontological lectures in Manchester, January, 1845.

† Lectures on Agricultural Chemistry, by Sir R. Kane, Cork, 1841.

Mr. Jones, in his anxiety to prove that mica-schist could contain no organic remains, forgets that primitive limestone is a metamorphic rock as well as mica, and is supposed by geologists to have been derived from the plutonic series. Now, as limestone does contain carbon, it follows, that carbon did exist when the plutonic rocks were formed, or, that metamorphic rocks are not derived from the plutonic. Let Mr. Jones choose the alternative.

Nor does Dr. Brayley account more satisfactorily for the absence of organic remains in marble, by ascribing the cause to the influence of the sun's rays.*

Mr. Lyell's account of the origin of the lias-formations is no less extravagant. "If," says he, "we now endeavour to restore, in imagination, the ancient condition of the European area, at the period of the oolite and lias, we *must conceive* a sea in which the growth of coral-reefs and shelly-limestone, after proceeding without interruption for ages, was liable to be stopped suddenly by the deposition of clayey sediment. Then, again, the argillaceous matter, devoid of corals, was deposited for ages, and attained a thickness of hundreds of feet, until another period arrived, when the same space was again occupied by calcareous sand or solid rocks, of shells and coral, to be again succeeded by the recurrence of another period of argillaceous deposition. In order to account for such a succession as these formations exhibit, we *may imagine*, first, the bed of the ocean to be the receptacle for ages of fine argillaceous sediment, brought by ocean-currents, which may have commenced with rivers, or with part of the sea near a wasting coast. This mud ceases at length to be conveyed to the same region, either because the land which had previously suffered denudation is depressed and submerged, or because the current is deflected in another direction by the altered shape of the bed of the ocean and neighbouring dry land. By such changes, the water becomes once more clear, and fit for the growth of stony zoophytes. Calcareous sand is then formed from comminuted shell and coral, or, in some cases, arenaceous matter replaces the clay, because it commonly happens that the fine sediment being first drifted furthest from coasts, is subsequently overspread by coarse sand after the sea has grown shallower, or when the land, increasing in extent, has approached nearer to the spots first occupied by fine mud."

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* Geological lectures in Cork, June, 1844.

"In order to account for another great formation like the Oxford-clay again covering one of coral-limestone, we *must suppose* a sinking down like that which is now taking place in some existing regions of coral between Australia and South America. The occurrence of subsidences on so vast a scale, may again have caused the bed of the ocean, and the adjoining land throughout the European Sea, to assume a shape favourable to the deposition of another set of clayey strata, and this change may have been succeeded by a series of events analogous to that already explained, and these again by a third series in similar order. Both the ascending and descending movements may have been extremely slow like those now going on in the Pacific;* and the growth of every stratum of coral, a few feet in thickness, may have required centuries for its completion, during which, certain species of organic beings may have disappeared from the earth, and others have been introduced in their place, so that in each set of strata, from the upper oolite to the lias, some peculiar and characteristic fossils were embedded."

We have given this long extract to show how modern geologists speculate by guesses and suppositions. Indeed, the difficulties not only of geology, but of almost every other science, would disappear were this mode of theorizing tolerated. Lyell's explanations of the phenomena of this science are of the strangest character. In speaking of the Paris basin, he says, "It is not improbable that the same convulsions which caused one part of the Paris basin to sink down, so as to let in the sea upon the area previously covered with gypsum, may have lifted up the *calcaire grossier* and silicious limestone." "This basin," he adds, "must belong to the Eocene period, and doubtless have required an *immense lapse of ages* for its accumulation."*

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* Lyell gives no proof that such a subsidence has occurred, or is going on at present, in the Pacific Ocean. And were it a fact, it would afford no justification of his unwarranted and extraordinary assumptions.

"In the strata of Triel, we have," says he, "compact fresh-water limestone, mingled with coarse marine limestone, through which microscopic testacea are diffused in countless numbers. It is very extraordinary, that in this instance, both kinds of sediment must have been thrown down together in the same spot, and each has still retained its own peculiar organic remains."† But to explain this phenomenon, he is at no loss for a theory: "We are," he states, "to imagine a gulf, into one extremity of which the sea entered, and at the other a large river." The sediments from these might, he thinks, have been deposited together, and account for the singular appearance.

In our opinion it would have been just as well to omit such explanations. They merely point out *one* possible means, out of a hundred, by which such effects might have been produced; but they do not convince the reader that such were really the means adopted in their production. Vague speculations may grace a romance, but a science must be based on facts and irrefragable arguments. Imagination can have no share in establishing its very principles.

But, while Lyell speculates thus largely, he is by no means disposed to concede the like privileges to others. "Many imaginary causes," he says, "have been invented to account for the transportation of *erratic blocks*, for example, the deluge, an agent in which a simple solution is so often found of every difficult problem exhibited by alluvial phenomena." Yes; to account for the peculiar position of these vast masses, by the only rational means known, is too simple a mode for modern theorists. A less simple solution is contained in the following hypothesis, though less satisfactory in the same ratio as it is complicated.

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* Geology, vol. iv, p. 187, &c.

† Ib. p. 183.

"It seems necessary," he adds, "*to suppose* that the Jura once formed a prolongation of the Alps, and that the portions of rocks were, at some remote period, detached from their Alpine summits, and transported to lower hills or platforms, which were destined afterwards to be upraised, and to form the independent chain called the Jura. Ice *may* have contributed its aid to the transfer of such blocks, for some of them are so enormous, that not even a flood like that in the valley of Bagnes, in 1815, can be supposed to transfer them by the power of water alone."*

It is too simple, forsooth, to imagine these masses of rock, enclosed as they might have been in enormous fragments of ice on the summits of the Alps, could have been torn from their foundations by a deluge which swept over the snow-capped heights of Mont Blanc and Monte Rosa, and transported to their present situations. No;—such a means, of whose reality we are convinced, is not sufficiently imaginative for great minds. The blocks must have been detached at some *exceedingly* remote period; the Jura must have been separated from the Alps; and that chain must have been subsequently elevated to its present position. The reader will judge which theory is more rational, which more probable, which entitled to more credit.

Had geological theories been true, they should involve no inconsistencies, give no contradictory results. Had the theories of rock-formation been probable, those of mineral veins, instead of rendering them still more perplexing, would tend but to confirm them. Rock-dykes and rock-veins are found in the same districts, in similar fissures, and under similar circumstances. "This difference," says Phillips, "is of such importance, that, however strong may be the arguments which tend to show that mineral veins are the result of igneous action among the masses of the globe, we cannot fail to perceive that this action was materially different in the two cases." That is, materially different in the production of dykes and veins. Whence could this difference arise if both are to be ascribed to the same cause, namely, " rents formed in the strata during the process of refrigeration" ?

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* Geology, vol. vi, p. 186.

In this geologists are not agreed among themselves, either as to the manner in which the rents or fissures were produced, or by what means they have been filled with the matter they contain. Phillips rejects " the rude notions of injection by heat, or solution by water,"* as being the agents by which they were filled, although Hutton and Werner, and their disciples, were the strenuous advocates of those identical " rude notions." How they were formed, and how they were filled, are questions which have long perplexed geologists. Some think the rents were made in the rocks in the act of cooling; others ascribe them to convulsions of the earth subsequently to the formation of primary rocks; but to whatever cause we refer them, all modern geologists suppose the formation of the metallic veins to have been after that of the rocks in which they exist.

Jones states, that " at the close of the formation of the carboniferous system of rocks, those convulsions that had agitated the world for so long a period, seemed to have closed. But, during the existence of those tremendous earthquakes and upheavings of the ground, most important had been the effects, as related to the prosperity of the human race. The clefts, the riftings in the earth, in the limestone-mountains, were left open; and age after age since that time had seen accumulating in these clefts, the metals that perhaps would never have been placed within the reach of man had it not been for this catastrophe; or, at all events, man would never have had an opportunity of working so successfully the mines that contained those riches, had they not been thus purposely produced by nature in situations where he could get at them." Mr. Jones attributes these convulsions of nature to " the result of the terrific conflict between fire and water;" for after the lapse of ages, he has an ocean ready at hand to cover the fiery nucleus of this planet. What chimeras! Are the works of the Most High, which are stamped with the most evident marks of design, to be thus made the subject of idle and capricious speculation.

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* Geology, vol. ii,—On Mineral Veins.

When mineral veins are intersected by rents or fissures containing extraneous matter, geologists conclude that these are later formations, and, at once, determine the geological epoch of each. In the mines of Cornwall, the *lodes* or veins which contain metal, and the cross veins, or non-metalliferous veins, mutually intersect each other. "In a few instances *the lodes* traverse the cross veins, but in a far greater number of cases, the cross veins cut through the lodes."* Were we to adopt the geological theory, we would, in Cornwall, have tin and copper, in one instance, an earlier formation than the rocks which intersect them; and again, in the same district, these metals would be later formations than those identical rocks through which they now form a passage.

Tin, silver, lead, and gold, are frequently found near the surface of the earth, but copper generally lies deep. The enormous deposits of this metal in Cornwall are 200 or 300 feet below the surface. In other places it lies far deeper. Were these metals effused from below, or deposited from water, they should occupy those positions which their respective specific gravities would naturally assign them; but such is not the case. Copper is lighter than gold, silver, or lead, and yet it generally lies deeper than either of these metals. Tin and copper are sometimes found together in the same vein, the tin disappearing at the depth at which the copper is discovered. Frequently the ores of both metals occupy the vein together to a great depth. Lead and copper are not unfrequently found together in slaty rocks in England and Wales.

Nothing so evidently disproves the geological theory of rock-formation as the positions in which the ores of metals are found. Lead exists in the lower rocks of the carboniferous series of England; while the metalliferous deposits of Scotland occur in primary and transition rocks. And whether granite be regarded as an early or a late formation, much of the Irish ores are found associated with it. Metalliferous veins are found traversing a great variety of stratified and unstratified rocks, and appear equally to belong to both. Geologists referring sedimentary and igneous rocks to different origins and to different epochs, are called on to show how veins of the same metals can traverse both classes of rocks; nay, how the same vein can possibly be continued from the stratified to the unstratified formation. Tin and copper in Cornwall are most productive at the junction of granite with the different varieties of slate, but no geological theory will explain the reason. Indeed, it would be too much to expect from the accidental operations of the elements, those results, which so strikingly evince the manifest design of the Creator, in the mineral as well as in the organic kingdoms.

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* Information for the People—No 97.

Lyell admits, that "the source from which bog-iron is derived, is by no means obvious, since we cannot, in all cases, suppose that it has been precipitated from the waters of mineral springs. According to Fourcroy, iron exists in all compact wood, and it is the cause of one-twelfth part of the weight of oak. The heaths which flourish in a sandy ferruginous soil, are said to contain more iron than any other vegetable."

"It has been suggested, that iron being soluble in acids, may be diffused through the whole mass of vegetables when they decay in a bog, and may by its specific gravity sink to the bottom, and so form bog-iron."* Then bog-iron comes, or may come, from vegetables! Whence came the other sorts of iron? Whence could vegetables derive iron if not from the soil? This seems an admitted fact, as the plants which grow in ferruginous soils contain more iron than any others. Animal blood also contains iron. May not animals, too, have contributed their quota to the supply of bog-iron? Perhaps extinct animals were created to furnish this useful mineral!

The production of iron from vegetable or animal substances; the pre-existence of iron in the soil where vegetables grow, and in the food of animals; the arrangement of metallic ores; the mutual intersection of metalliferous and non-metalliferous veins; the continuation of the same veins through igneous and aqueous strata—all concur with every other circumstance, to prove the coeval origin of all things, and to confirm the Scripture narrative.

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* Lyell's Geology, vol. iv, p. 204.

Experiments by Fox, Crosse, Bird, and others, go to prove that electrical currents have been powerful agents in the *arrangement* of metallic matter; but as to the manner in which it has been accumulated in these veins, no rational cause has yet been assigned, save that which the first act of creation furnishes; due allowance, however, being made for all those modifications to which matter, subject to natural causes, must be ever liable.

To what cause other than the evident design of the Creator can we attribute the existence of the most productive veins and nests of metallic ores, near the junction of the granitic and secondary rocks? These are, as it were, the fruits and flowers of the mineral world, placed by Almighty God in positions accessible to man, arranged by the same design, disposed by the same providence, and made subservient to the same purposes as the produce of the animal and vegetable kingdoms.

Modern theories respecting the formation of rocks cannot, therefore, be deemed irrefragable, while mineral veins present difficulties calculated to baffle the researches of philosophers. The theories which regard the formation of strata should not clash with those which refer to the accumulation and arrangement of metals; nor would they, had each been a portion of one system, in which all the parts concurred in the completion of the whole. If rocks be the products of fire and water, why not ascribe the formation of metallic veins to the same agencies? But, to suppose metallic ores, as they exist at present, to have been the result of effusion or sublimation from below, or of deposition from an ocean above, is fraught with too many difficulties; and hence, though maintained by some geologists, both are rejected by others as untenable.

Indeed, geological theories must be liable to serious objections while geologists are so reckless in devising them. A glance at a cliff or chasm is sometimes sufficient for them to judge of the strata of a district, and with the information derived from such slender data, to form hypotheses subversive of long-established opinions. "The short inspection of a mine," observes Phillips, "with the disadvantage of confused lights and noises, and explanations hid in phraseology of very difficult interpretation, leaves on the mind a feeling of disquieting disappointment. The important facts of the intersection of veins are not seen; the segregations of ore in a vein, the change of the contents with the change of ground, with the depth, the underlie, and other influential conditions, must all be taken on the affirmation of the agent, in whose office the stranger expects in vain to find a complete record of the subterranean operations, with all the scientific data which they have revealed. Dr. Boase was so impressed with these difficulties, that in his examination of the veins of Cornwall with a view to understand their formation, he declined to enter the mines at all, preferring to trust his reasonings on the phenomena in the sea-cliffs which he could accurately examine, than on the almost innumerable facts which the mining art has disclosed, only to be, in many cases, lost for ever to science."*

How uncertain must be the inferences, and how vague the arguments, which are based upon such data! and yet, how frequently have the theories of geologists no better nor more trustworthy foundation! Doctors wanting physical courage to enter a mine, and miners wanting science to deduce just conclusions from known facts, are generally those to whom others look up for information on subjects which demand the experience of the miner, the science of the scholar, and the virtue of the Christian, combined in the individuals who are to be our instructors.

It is true, we can sufficiently comprehend the useful and practical portions of geology from the experience of ordinary observers; but it is equally true, that theories which relate to the origin of matter, to geological epochs, to successive creations of organic beings, to indefinite periods of time, in a word, to any doctrine opposed to the obvious meaning of the Sacred Scriptures, should not be confided to timid doctors, to ignorant miners, or to flippant lecturers.

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* Phillips' Geology, vol. ii,—Mineral Veins.

We cannot, therefore, give implicit credit to the geological opinions of Lyell or Buckland, of Jones or M'Culloch, when these are not based upon surer foundations than were those of Whiston or Burnet, of Hutton or Werner.

CHAPTER XVI.

Central heat—First hypothesis to explain the phenomena of earthquakes, volcanoes, &c.—Second hypothesis—Chemical action—Objections to first hypothesis—Effects of water in contact with the central heated nucleus—Chemical phenomena of volcanoes not deducible from central heat—Earthquake-waves—Objections to the theory of central heat—Changes of climate—Ice of Mount Etna—Central heat incapable of changing the climate of Siberia—Anxiety of geologists to establish a central fiery mass—Hydrogen—Sources of heat—Combustible nature of mineral bodies—The chemical hypothesis accords with observed phenomena—Heat in mines—Experiments showing the amount of heat in mines—Heat in mines not the effect of a fixed cause—Temperature of the ocean—Experiments—Singular property of water—Effects which should result from a central heat—Temperature of mines and ocean contrasted—Conclusion.

Almost all modern geologists agree in the opinion, that a very high degree of heat exists in the central parts of the earth; and they ascribe to its agency, the formation of primary plutonic rocks. By this hypothesis, also, they account for the absence of organic remains in the unstratified formations, and for a supposed former high degree of temperature, in regions far distant from the torrid zone. Fossils of organic beings now discovered in the temperate and frigid zones, appear to have belonged to creatures, whose nature seemed congenial to climates far different from those in which these remains are found. The gradual increase of heat, observable in descending into mines, the phenomena of artesian wells and thermal springs, are also adduced as confirmatory proofs of the existence of a central fiery nucleus.

Others imagine they deduce a proof of central heat from the phenomena of volcanoes, by the following *indirect* mode of argument. "If," say they, "the earth be now generally hot within, it must have formerly been much hotter. In the process of cooling, the exterior solidified part, and the interior fluid parts, contract unequally, a general pressure and tension result, and the crust breaks locally, to restore the equilibrium. Hence, earthquakes and fissures, on some of which volcanic vents are established, which serve more or less to relieve the subterranean pressure, as earthquakes also do. If, in addition to this general view, we suppose the admission of water through fissures, to particular parts of the *ocean of molten sea*, it is easy to see, that the observed mechanical phenomena of volcanoes and earthquakes will result, as the effect of a local excitement, superadded to a general operation."*

Were all the phenomena of earthquakes and volcanoes explicable by the supposition of an internal heated mass, and were there no other causes in operation, from which similar results could be inferred, it may be necessary to admit the reality of this fiery nucleus. But, when all these phenomena cannot be explained by such an admission, and when the *chemical hypothesis* affords an easy and natural solution to them all, it follows that the arguments deduced from volcanoes and earthquakes, in support of a central heated nucleus, cannot be admitted as evidence, much less of demonstrative evidence, in the case.

The *chemical hypothesis* supposes, what is, in fact, almost certain, that "when water enters in great quantities to the foci of volcanoes, and then comes in contact with the metalloid bases of the earths and alkalies, and some chlorides, (especially the chloride of sodium), the following effects will happen :—one part of the liquid will be quickly decomposed ; the metals and chlorides will seize oxygen, and be thereby converted into silica, alumina, lime, magnesia, soda, &c., substances which predominate in lavas ; the hydrogen will be liberated in the state of gas, or in combination with chlorine, and will form hydrochloric acid, which is known to be very often present in the vaporous exhalations of volcanoes........The heat generated by the primary chemical action (oxygenation), and the energetic action of steam, to which part of the water is converted, are thought sufficient to account for the mechanical phenomena of volcanoes."

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* Phillips' Geolgoy, vol. ii,—Volcanoes.

"If, at the depth of three or four miles, the nucleus of the earth consists of the metalloid bases of the earths and alkalies, with iron and other metals, partially combined with sulphur, the new oxygenation to which, under ordinary conditions, they could be subject, may be productive of no other phenomena, than a moderate rise of temperature in the neighbouring rocks, or in thermal springs. But, *with excess of water*, and especially sea-water, the effects of the heat generated will become more formidable—oxygenation on an extensive scale, and evolution of a large volume of hydrogen, again to combine with oxygen, (supposing atmospheric air present), or with sulphur, *at a high temperature.* In the former case, nitrogen gas will be liberated, which may rise uncumbered, or may unite with hydrogen to form ammonia ; and this will be neutralized by free muriatic acid, and produce sal-ammonia. The hydrogen not thus disposed of, may combine with sulphur, to form sulphuretted hydrogen gas ; but this may be again decomposed by rising and meeting with oxygen. As long, therefore, as oxygen abounds, there will be evolution of water and sulphureous acid ; afterwards sulphuretted hydrogen will prevail towards the end of the eruption. As long as heat remains in the lava, the combustion of sulphur, and the decomposition of the sulphureous acid by sulphuretted hydrogen, would regenerate water, to maintain by combination with metals and metalloids, a continuance of similar, though feebler, actions."*

The first hypothesis is objectionable, as no cause can be shown why any part of the "*molten sea*" should rise to the surface of the earth, as the lava of volcanoes is known to do. If, by the rending of the earth's crust, the internal fluid mass is subjected to any extraordinary pressure, so as to change its form, then the fluid matter may burst forth wherever the crust is weakest, as well as in the immediate vicinity of the fracture. Should the matter be ejected, where the fracture is made, it should come forth from every part of the rent or fissure, and not as from the crater of a volcano. There should also appear a corresponding depression of the external crust of the earth, near that part where the fracture had been made, as no pressure could have been caused, unless the fractured crust had fallen in upon the fluid mass. Nor could the melted matter have been raised, as through the craters of volcanoes, without such a pressure from without. But as no such appearances occur, even where volcanoes are most numerous and violent, they cannot be referred to a central fluid nucleus; and, consequently, no proof of the existence of such is obtained from *this* theory of volcanoes.

If water came in contact with this supposed molten sea, steam would be generated, and the superincumbent mass of earth cast up; but how the surface of the earth remains unmoved, and only lava sent forth through the orifice of the volcano, are facts not in accordance with this theory.

The idea of ascribing the cause of volcanoes to the pressure on an internal fluid mass, by the external crust of the earth, is shown by Lyell to be absurd; and though his arguments are conclusive against a central fiery nucleus, they do not apply to the effects which the *chemical theory* is calculated to produce; for, though the incandescent masses in this case may be great, they are still too limited in extent and amount to melt down the earth's crust, or any considerable portion of it. Besides, volcanic vents and an external ocean are sufficient to counteract such effects.

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* Phillips' Geology, vol. ii,—Volcanoes.

An eminent modern geologist observes, that "there is not on record, any attempt to deduce all the chemical phenomena of volcanoes from the hypothesis of general heat below the surface of the earth." Nor is there, we believe, any argument on record, which *demonstrates* the existence of any such general heat, although many arguments are on record in support of this opinion. How, it is asked, could the *wave-like* motion of some earthquakes have been produced, had there been no central liquid mass to convey them? "Could the impulse observed at the period of the Lisbon earthquake have been propagated thence to the West Indies, Loch Lomond, and Italy, were there not an internal wave in the central semifluid mass within?"

Admitting the existence of such a fiery nucleus, it has never been shown how such a wave could have been generated in it. But because an earthquake-wave is sometimes perceived, which cannot be satisfactorily accounted for, this theory is adopted, in order to explain the undulatory motion, by the central-fluid, and to demonstrate the existence of the fluid, by the external wave-like motion. This mode of argument is neither correct nor conclusive, unless conclusive in demonstrating the fallacy of accounting for a phenomenon by a supposititious cause; and then establishing the reality of the cause by that same phenomenon.

Were it possible for such a central fluid-mass to exist, it would either fill up the cavity of the earth's crust, or it would not. In the first case, no wave could have been formed, as it is well known that liquids thus confined, possess the properties of solids.* In the second case, no partial pressure upon any part of the liquid could force it to the surface of the earth, as the compressed part could flow towards the vacant space within, rather than rise to

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See Arnott's Physics, vol. i, p. 494.

an elevation, many miles above the general level of the central fluid. Again, were there a vacant space within the hardened shell of the earth, what could support the vast arch which should span the vacuity?

The variations of climate, which are supposed to have occurred, are ascribed by some, to changes in physical geography; by others, to a change in the rotatory axis of the globe, and, consequently, to a corresponding change in the relative positions of the equator, ecliptic, zones, &c.,—but a far greater number of modern philosophers attribute this to a central-heat. This, however, cannot be admitted. The surface of the earth may, indeed, be heated, had such a nucleus existed, but the higher regions of the atmosphere would not participate in the increased temperature, at least not to that amount necessary to communicate to the temperate and frigid regions of the earth, a tropical climate. A soil only sufficiently warm to grow tropical plants, could not fit the atmosphere for the animals of the torrid zone. Professor Ansted remarks, "They (geologists) had no right to conclude that the climate was *very* different, but they might conclude that there was a difference between the general conditions of these countries now, and in the tertiary periods."

A remarkable discovery was lately made on Etna, of a great mass of ice, "preserved," says Lyell, "for many years, perhaps for many centuries, from melting, by the singular accident of a current of red hot lava having flowed over it. I visited the greater crater in December, 1828. I found the crevices in the interior incrusted with thick ice, and in some cases hot vapours were actually streaming out between masses of ice and the rugged and steep walls of the crater."*

If this mass of ice could have been preserved at an elevation of about 10,000 feet with an incandescent sea within the mountain, and a red hot torrent of lava above, with only a slight bed of scoriæ to preserve it from the lava, and a few feet of earth to defend it from the melted matter beneath, how can we suppose that a central nucleus, covered with a crust hundreds of miles in thickness, could convert the icy regions of Lapland or Siberia to a climate analogous to that of the tropics? The ice upon Etna is preserved amidst the smoking ruins of the crater; and the snow remains unmelted on the active vents of the Andes; and will any one suppose that a heat at the surface of the earth, arising from any *internal* cause, only sufficient to produce vegetables of tropical growth, could make the Northern Ocean like the Gulf of Mexico in temperature, or convert the dreary wastes of Siberia, or the Northern regions of North America, into countries resembling Brazil or Hindoostan in climate and natural productions?

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* Principles of Geology, vol. ii, p. 177.

The chemical hypothesis affords the most satisfactory explanation of the phenomena of earthquakes, volcanoes, thermal springs, &c.; while the theory of central heat gives no plausible reason for many things connected with these extraordinary appearances. The various gases which volcanoes emit, could not have been produced by the admission of water through the fissured crust of the earth to a central heated nucleus; but the chemical hypothesis accounts for them sufficiently.

When water comes in contact with the metallic bases, vast volumes of hydrogen are evolved during the process of saturation; and the hydrogen thus generated "might permeate the crust of the earth in different directions, and be stored up for ages in fissures and caverns in a liquid form under the necessary pressure. This hydrogen also, on coming afterwards in contact with the heated metallic oxides, may reduce them again to metals; and this circle of action may be one of the powerful means by which internal heat, and the stability of the volcanic energy, are preserved."*

The various ways in which heat is generated are very mysterious: sometimes much heat is evolved by the simple mixture of two or more seemingly cold bodies, as oil of vitriol and water, nitric acid with oil of turpentine, phosphuretted hydrogen and water, and several other mixtures. Friction, hammering, compression, &c., are other sources of heat. Sulphur and filings of iron, worked into a paste with water and buried in the earth, ignite in a few hours, and produce effects similar to those which accompany earthquakes. Vegetable matter, piled together in a humid state, heats, and frequently inflames. Hay, straw, bark, &c. have often been consumed by fire produced in this manner.

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* Lyell's Geology, vol. ii, p. 373.

The combustible nature of the elements of the earth's crust; the facility with which their compounds may be decomposed, and made to enter into new combinations; the quantity of heat they evolve during these operations; the fact that water is composed of two gases, whose union produces intense heat;—these will account for every phenomenon in which heat is the agent, without the aid of this imaginary central nucleus, or any hypothesis by which reason and religion are compromised. Heat, or rather caloric,* seems to exist in a perceptible or latent state in all bodies, and can be developed in various ways; hence, to explain those phenomena which depend on it, we need not recur to strange or fanciful theories, which generally involve greater difficulties than those they are intended to solve.

Water is found in all places at greater or less depths below the surface of the earth, and descends to unknown depths, variable according to circumstances. As there are so many bodies in nature which produce heat in contact with water, the phenomena of earthquakes, volcanoes, thermal springs, pyrogeneous rocks, &c., may be manifested in countries where sulphur, nitre, iron, &c., abound. Accordingly, we find earthquakes and volcanoes in some localities, where these substances are in excess; thermal springs, pyrogeneous rocks, &c., in places where they abound less. The heat observable in mines may be traced to similar causes, as the variable quantity in different mines demonstrates. Geologists refer these facts to a central heated nucleus, but they really belong to the class of effects accounted for by the chemical theory.

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* Heat is the feeling or effect produced by caloric, which is the principle or cause of heat. Generally, the effect is named for the cause.

That the earth has a general and pervading high temperature below the surface to an unknown depth, is undeniable; and we dispute not the fact but the cause. In descending from the surface to depths continually increasing, the mean temperature increases gradually. At one foot below the surface, the mean temperature is supposed to be a *minimum.*

By experiments made by Mr. Fox, in 1837, in the Levant tin and copper mines, the general ratio of increase was 1° for every 45 feet of depth. The experiments in the salt-mines of Cheshire evince an increase of 1° in 70 feet from the surface. Those of Mr. Bald give 1° for distances varying from 42 to 48 feet. M. Arago's experiments on artesian wells give a ratio of increase of 1° for 45 feet. Mr. Henwood's observations in slate and granite rocks, show the former to possess a higher temperature by 3·9° at the same level, and the progressive degree of temperature in descending varies from 39 to 41½ feet for each degree of increased heat. From these facts we may be led to imagine that 1° in 45 feet would be a fair average, and that these changes of temperature arise from an invariable cause. Such, indeed, is the conclusion arrived at by the advocates of a central heat, and, accordingly, they deduce their strongest arguments in support of this opinion from such facts as those just enumerated.

But there exist so many anomalous cases, that, in fact, no determinate scale of increase can be assumed; and, moreover, they demonstrate that such changes of temperature could not proceed from any fixed cause.

By experiments made in coal-pits 1584 feet deep, in 1834, at Monkwearmouth, Sunderland, the ratio deduced was 1° in 60 feet of depth. At Manchester, the ratio obtained was 1° in 69 feet. At Wigan, 1° in 60 feet; while at Bedminster, under the superintendence of Mr. Sanders, the ratio was as high as 1° in 30 feet. By experiments made in the lead and silver mines of Junghohe-Birk, in Saxony, it was 1° in 102·4 feet, though in other mines *of the same country*, it varied from this amount to 18·8 feet per 1° of heat. In the mines of Brittany it varies in the following order, viz.:

1° in every 36·4 feet of depth.
1° 48·4
1° 57·4
1° 82·
1° 89·5
1° 182, and
1° 351 ! !*

That such extraordinary variations should be the result of a *fixed cause*, is what no one *ought* to credit; and hence, the theory of central heat is not sustained by those very facts upon which its existence was at first presumed.

M. Cordier gives as the result of his experience and observation on the temperature of the earth's interior, that "the heat increases rapidly with the depth; but the increase does not follow the same law over the whole earth, being twice or three times as much in one country as in another; and these differences are not in constant relation either with the latitudes or longitudes of places." All this is precisely what we should have expected to arise from variations in the intensity of volcanic heat, and from the change of position which the principal theatres of volcanic action can be proved to have undergone; they depend not upon a central heat; they accord with chemical action; they require no interminable epochs for their accomplishment, and are perfectly compatible with the Mosaic narrative; a narrative to which no phenomenon of the mineral creation is opposed.

But this conclusion is rendered still more certain by a series of different experiments. "If," observes a modern geologist, "the earth be very cold within, the influence of the interior cold will begin to be felt below the depth of one hundred feet; if very hot within, the rate of increase of this heat may be inferred from exact and numerous observations." Such observations have been made, and on land, a gradual augmentation of heat has been discovered to exist, though varying in amount in different localities. Had this heat, which is so manifest on land, proceeded from a fixed, invariable cause, that is, from a central fiery nucleus, it should also manifest itself in the ocean. The bottom of the sea being far deeper than the deepest mine ever yet explored, is, consequently, nearer the heated nucleus, and should feel its effects. If the earth were very hot within, the water at the bottom of the sea should be hotter than the water at the surface—even hotter than the water at the surface in the torrid zone, because the heat of a mine, as deep as the bottom of the sea, would be far greater than the surface-heat of the torrid zone. The waters of the ocean should, therefore, increase in temperature according to the depth, and this phenomenon should be more and more evident in high latitudes. Is it so? No; the very reverse is the fact; and the general law, that "the *cold augments* with the depth," has been recently confirmed by a variety of experiments in different parts of the ocean.

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* Phillips' Geology, vol. i, p. 19.

In the South Sea, lat. 18° S., long. 125° W., the heat at the surface being 79¼°, at the depth of one hundred fathoms it was 70½°; and at two hundred fathoms only 54½°. In lat. 12° N., the surface-heat was 83¾°; at eighty fathoms it was only 63½°. In lat. 29° N., the heat at the surface was 74°; at one hundred fathoms 63½°, and at three hundred fathoms 53°. And in lat. 36° N., long. 47° W., the surface-heat being 72½°, at one hundred fathoms it was 53°; at two hundred fathoms 47¾°; at three hundred fathoms 44°; and at four hundred fathoms 42¾°. These are but few of the many experiments made, all tending to prove a gradual diminution of heat as far as has yet been sounded, lessening, sensibly, per one hundred fathoms, as the depths augment.

"Now, the sun's rays rarely penetrate below the depth of forty-five fathoms, or according to some, of one hundred and thirteen fathoms, below which the sea receives no light, and, consequently, little or no heat from the sun."* Mr. Chambers says, that "the solar rays can only penetrate about three hundred feet below the surface, nor does light descend any further."† But experiments show a diminution of heat to ten times this depth, where, of course, the sun's rays could exercise no influence. To what cause, then, but to the *interior cold*, can we ascribe the decreasing temperature, at depths greater than one hundred and thirteen fathoms, the maximum depth to which the sun's rays are supposed to extend?

That the temperature never descends to the freezing point, is not to be attributed to an internal heat, but to that singular property of water, by which it expands by cold, from about 40° to the freezing point. This expansion renders the water specifically lighter than the stratum above of a higher temperature, and it consequently ascends, and thus the water at the greatest depths can never be cooled down to the freezing point.‡ The hot and cold waters are constantly interchanging positions, and the equilibrium temperature of the ocean is thus preserved. Even were it a fact that "there is no maximum of density of salt water, no point, as in fresh water, at which an increase of cold causes the fluid to begin again to expand;"§ still, all the experiments hitherto made go to prove, that cold in the sea increases with the depth; and though the progressive increase may not be uniform, still no conclusion favourable to a central heat can be deduced; on the contrary, all the inferences

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[*] London Encyclopædia, vol. xvi, p. 104.

[†] Information for the People, No. xxvi, p. 403.

[‡] In very deep seas the temperature descends as low as 32°, but it never reaches the still lower degree at which the ocean-brine is known to congeal.

[§] The freezing point of sea-water is about 27° Farn.; hence, the ocean-brine may be frozen in the frigid zones; and though ice-bergs are composed of fresh water, yet the fields of ice which appear not above the ocean-level, are not exclusively of fresh-water origin. As ice composed of sea-water floats as well as other ice, it must be specifically lighter than water, and, consequently, the water which formed it, must have expanded by the cold which changed it into ice. We do not, therefore, think there is any proof to show that sea-water forms an exception to the law by which water contracts by cold only to the temperature of 40°. See Dr. Arnott's Physics, vol. i, p. 318.

drawn from these experiments, lead to the opposite conclusion.

Had there been a central heated nucleus, it should affect the bottom of the ocean. Geologists imagine they can recognise its effects in mines, wells, &c., at a few yards below the surface of the earth; its effects, therefore, ought to be more manifest at still lower depths. Now, had the bottom of the sea been warm, the waters should exhibit lower degrees of temperature from the bottom upwards, to that point at which the sun's influence is felt, and, in many instances, far above this limit. But this is not the case; and hence, no fact can be more conclusive, in proving that no such fiery nucleus exists in the central regions of the earth.

From the facts enumerated, it appears that the temperature of the ocean in very deep seas is precisely what it would be, had the centre of the earth been cold. Experiments prove, that the temperature approximates the freezing point in very deep water, and the expansive property of water, at that temperature, precludes the possibility of lower degrees of heat, whatever be the interior state of the earth. An ocean, exposed for thousands of years to the heat of an internal mass of fire, could not be as cold as if no such fire existed; yet, the reverse is the conclusion to which these facts would lead;—an additional proof that no such central heat exists.

If we suppose a deep mine in lat. 36° N., the following table will show the respective temperatures on land and sea, at corresponding depths, allowing 1° of heat for every forty-five feet deep on land.

Depths.	Land.	Sea.
At the surface	72½°	72½°
100 fathoms	85⅚	53
200 do.	99⅙	47¾
300 do.	113½	44
400 do.	127⅚	42¾

Thus, on land, at the depth of four hundred fathoms, the temperature would be 127⅚°, and at sea only 42¾°, and both, according to geological theories, arising from the same cause, namely, an internal fiery nucleus. The difference of the sea and land temperatures is greatest where in reality it should be least, as at such great depths both sea and land are less liable to be affected by the season or by the latitude.

It has been observed that in mines, the difference of temperature exhibited by air, water, stones, &c., is very little, particularly when these are exposed for any length of time to similar influences. Bodies in the same room, when tested by the thermometer, exhibit equal degrees of temperature.* Now, were the central part of the earth a fiery nucleus, we should expect to find earth and water, at equal distances from this heated mass, exhibiting equal or nearly equal degrees of temperature, especially when apart from all other sources of heat; but such not being the fact, as the experiments alluded to demonstrate, it follows that the source of heat in mines must be very different from that fixed cause which a central nucleus would supply; and here again are corroborating proofs that no central nucleus of heated matter exists in the interior of the earth.

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* Arnott's Physics, vol. ii,—article on Heat.

CHAPTER XVII.

Geology contrasted with other sciences—Legitimate objects of Geology—Mosaic narrative, and geological theories—Geological science and geological romance—Infidel systems—Geology and Scripture—Lamarckian theory—Opinions of Sir H. Davy—Objections by Lyell—Opposite sentiments of Buckland and Ansted—Successive creations of organic beings—Theory of Linnæus—Objections by Lyell—Lyell's theory of successive creations—Objections—Extinct animals—Introduction of new species—Organic kingdoms constitute perfect systems—Mutual relation of organic beings—Checks and counter-checks in the organic kingdoms—Consequences resulting from changes in physical geography—Systems of geologists, and systems of creation—Decay of species—Conclusion.

Having dwelt at so much length on the difficulties which the mineral world opposes to the theories of geologists, we turn to the animal and vegetable kingdoms, to ascertain whether the facts which they disclose, and the obvious inferences flowing from them, are calculated to confirm our objections, or to establish the rash geological opinions adopted, and show them to possess all those conditions which systems based on truth and science must ever exhibit.

In acquitting ourselves of this task, we look upon geology in the same light as we view chemistry, astronomy, physical geography, or any other natural science. In these we seek to know, not what *may* be possible or impossible; what *might*, or *might not*, have happened, but what actually *is*, and what *has* actually taken place.

In astronomy, the positions, motions, magnitudes, &c., of the heavenly bodies are the objects of inquiry. In chemistry we seek to know the chemical union of substances, their various combinations, and the effects resulting from such combinations; the ingredients, or constituent parts of bodies, &c. In geology, the nature and position of rocks, the classification of strata, the natural effects resulting from the action of the elements, &c., should constitute the matter of study, and not vain and fanciful theories, which involve difficulties that man's limited under-standing is unable to fathom. What can man know of the origin of substances, when he can form no adequate idea of what *substance* is? He can study the sensible qualities of bodies, as taste, colour, form, magnitude, &c., but of their substances he can learn nothing. Attempts to account for the origin of things by natural means, involve doubts and difficulties; but, referring the origin, as well as the subsequent arrangement of matter, to the creative power of God, all difficulties are removed, and all danger of error is obviated.

Geological theories suppose an endless variety of minerals, existing, as they now do, by the agencies of fire, water, &c. The Mosaic narrative points out an All-powerful God giving to the mineral world all that order and beautiful variety which he has stamped on the animal and vegetable creation. Geological theories require countless myriads of years to produce what the mineral world unfolds. The Mosaic narrative shows them starting into existence at the word of the Creator, like the ocean, the atmosphere, or the celestial bodies; subject, however, to those varying conditions, to which matter, in all its forms, must be for ever liable.

If rocks were formed from pre-existing matter, as geologists imagine, by the agencies of fire and water; soils, from the worn-down materials of rocks; chalk, limestone, &c., by animals; coal, from vegetable deposits; iron, from the organic kingdoms, &c.; then, all the objections which can be urged against the existing order of things, will apply with equal force against the former conditions of those materials, whence the present classes of bodies are derived. And these objections can be again and again repeated, and the whole system of geology, as it now stands, reduced to one unmeaning, endless round of unsatisfactory inquiries. Besides, the subject is more and more perplexed by every attempt to explain by mere natural causes, those effects which only the act of creation can account for.

What geologist will coincide in the opinion of one who asserts, that animals were first produced in the following manner? The skeleton of the first elephant, for instance, was formed by nature, of calcareous matter, in the lapse of indefinite ages; the tusks and teeth were the crystals of this primary *lusus naturæ;* the flesh, a subsequent vegetable deposit; and the skin, a still later formation. Life was but a link in that series of transmutations, by which, according to the Lamarckian theory, irrational creatures passed finally into man.

Absurd as such a theory would be, it is not more so than that which supposes it possible for the endless variety of minerals now in existence, to have been produced from that chaos in which geological opinions involve the origin of those substances which form the earth's crust. Like those who pretend to the utmost exactness in every minor observance, yet in matters of moment are remiss and negligent, geologists investigate some circumstances with all the rigour of geometrical demonstration, whilst others, of far more importance, are either assumed, or admitted without the shadow of proof. The deluge, which overtopped the highest mountains, is deemed too feeble an agent for transferring the erratic blocks to their present positions, and, in the judgment of modern philosophers, affords no proof that these masses of rock could have been removed within the historic period, to the places they now occupy; and yet, they not only admit, but positively affirm, that all the crystals, precious stones, metals, and the endless variety of minerals which exists in the earth's crust, were produced from one mass of liquid fire, in which they suppose this earth to have once been enveloped. And upon what evidence is this conclusion arrived at? On proofs in their nature the most puerile and extravagant; proofs that would not be admitted in any other department of science.

Against such unwarranted inferences, and not against the just and legitimate conclusions deduced from authenticated facts, are we anxious to direct the attention of those who feel conscious that the truths of science and those of religion can never be at variance. For, should the phenomena of nature appear to clash with the truths of revelation, to our limited reason and imperfect knowledge of God's works, and not to opposite principles in a Being of infinite power and wisdom, should we attribute the seeming discrepancy. The truths of astronomy triumphed over every obstacle raised to oppose them, while the truths of faith, protected by Catholic interpretation of Scripture, were equally triumphant.

Not so with the systems which infidelity framed for the overthrow of Christianity. They were fabrics of sand, which have long since crumbled to ruins, although, " in 1806, the French Institute alone counted eighty such theories, hostile to Scripture."* These visionary theorists had comets at will to form this earth, and destroy it again, without any regard to the book of Genesis, which tells of its creation;† or to the express declaration of our Divine Redeemer, as to its final destruction.‡

Geology now is at variance with Scripture on points of the utmost importance. The book of Genesis limits the creation of the world to six ordinary days. Geologists affirm these days to have been periods of time incalculably great. The Scriptures declare, that at the creation, animals were ordered to increase and multiply and people the earth; and that " God rested on the seventh day;" that is, ceased from creating any new kinds of creatures.§ Geologists teach, that successive races of beings, *quite distinct* from those that preceded them, have existed through different geological epochs, and that even still, new animals are being created, whilst old species are gradually passing away, or actually *dying out.* The Holy Scriptures tell us that all things were made for man's use and benefit. " And God said, Behold I have given you every herb bearing seed upon the earth, and all trees that have in themselves seed of their own kind, to be your meat, and to all beasts of the earth, and to every fowl of the air, and to all that move upon the earth, and wherein there is life, that they may have to feed upon."* But geological theories give us to understand, that countless races of animals and vegetables existed on earth during millions of years previous to the creation of man; that these races were overwhelmed in frightful convulsions, to which they imagine this earth to have been subject; and that all these revolutions had no reference to man, unless, peradventure, to prepare the earth for his coming. The book of Genesis† informs us that the tenants of each element were created simultaneously: the waters produced the great whales, and every living and moving creature at the same time; the winged fowls of the air sprang into existence all together; the beasts and creeping things are coeval. But some geologists suppose, that the earlier animals, of less perfect organization, were but "the abortive efforts of nature" to produce the more perfect races which succeeded.

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* Cardinal Wiseman's Lectures on Science and Revealed Religion, vol. i, p. 207.

† Gen. i.

‡ Matt. xxiv, 36.

§ Notes to Genesis, c. ii, Douay Bible.

Lamarck and his followers assert, that *nature* cannot produce animals and plants of all classes at once; that, being a delegated power, a mere instrument, a piece of mechanism, acting by necessity, she is obliged to proceed gradually in all her operations, must always begin by the formation of the most simple kinds, and out of them elaborate the more compound; adding to them successively different systems of organs, and multiplying more and more their number and energy. They assert that this *nature* is daily engaged in the formation of the elementary rudiments of animal and vegetable existence, which correspond to what the ancients termed spontaneous generation; that she is always beginning anew, day by day, the work of creation, by forming *monads,* or rough draughts, which are the only living things she gives birth to directly; that these are gradually developed unto the highest and more perfect classes, by the slow, but increasing agency of two influential causes, namely, the *tendency to progressive advancement*, and the *force of external circumstances*, or of variations in the physical conditions of the earth, or the mutual relations of plants and animals."

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* Gen. i, 29, 30.

† Ch. i, ver. 20, &c.

Lyell ably refutes this Lamarckian theory, and shows that no habits of animals, no necessities to which they can be subject, are capable, in any way, to change the organization, or vary their nature or form;* but he admits, that variations in the physical conditions of the earth require corresponding variations in the organic beings which occupy it. Accordingly, he supposes the introduction of new creatures, not by the *influential causes* and *monads* of Lamarck, but by the operation of that power by which the first races were formed. The Lamarckian theory supposes a gradual tendency in species to *progressive advancement.* The Lyellian hypothesis, on the contrary, affirms a gradual decay of species, similar to that of individuals. Both, however, are extreme cases, and the truth is equally distant from each. Species neither advance, nor retrograde, to an extent sufficient to to justify the opinion of Lyell or Lamarck. They may perish or become extinct in extraordinary cases, but while no "set of ancient causes, different from modern ones," can be shown to have existed, there can be no sufficient reason assigned why species should have undergone any material alteration.

"In those strata which are deepest," remarks Sir H. Davy, "and which must, consequently, be supposed to be the earliest deposited, forms of vegetable life are rare; shell and vegetable remains are found in the next order; the bones of fishes and oviparous reptiles exist in the following class; the remains of birds, with those of the same genera mentioned before, in the next order; those of extinct species in a still more recent class, and it is only in loose and slightly consolidated strata of gravel and sand, and which are usually called diluvium formations, that the remains of animals, such as now people the globe, are found, with others belonging to extinct species. But in none of these formations, whether called secondary, tertiary, or diluvial, have the remains of man, or any of his works, been discovered; and whoever dwells upon the subject must be convinced, that the present order of things, and the comparatively recent existence of man, as the master of the globe, is as certain as the destruction of a former, and a different order, and the extinction of a number of living forms, which have no types in being. In the oldest secondary strata, there are no remains of such animals as now belong to the surface, and in rocks, which may be regarded as more recently deposited, these remains occur but rarely, and with abundance of extinct species;—there seems, as it were, a gradual approach to the present system of things, and a succession of destructions and creations, preparatory to the existence of man."

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* Principles of Geology, book iii.

The progressive development of organic life, from the simplest to the most complicated forms, is said by Lyell to have a slender foundation in fact;—the popular theory, he says, of the successive development of the animal and vegetable world, from the simplest to the most perfect form, rests on a very insecure foundation. Dr. Buckland, however, is of a different opinion, and says, "We may collect an infinity of arguments to show that the creatures from which all those are derived, were constructed with a view to the varying conditions of the surface of the earth, and to its gradually increasing capabilities of sustaining more complex forms of organic life, advancing through successive stages of perfection."*

Professor Ansted agrees with Lyell, and says, "It was interesting to find, that the first appearance of animals was not in the most simple form, but on the contrary, that they were characterized by rather a high organization: this was a truth taught in geological investigation, in contradiction to many, who asserted that there was a gradual advance in organization, from fossils of a lower to those of the upper series; an opinion which was clearly disproved by the most recent investigation."

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* Buckland's Geology, vol. i, p. 107.

He coincides in the opinions of Lyell as regards successive creations of organic beings, thus: "The fossils in the silurian deposits in Wales are of considerable interest, because they indicate the first conditions of life upon this globe. In the way of vegetables, the only remains were portions of sea-weed, which were occasionally found. But the fossil of greatest interest, found in connexion with these rocks, was an animal of a very curious description, coated all over the body with a number of horny plates. These animals seemed to have existed in enormous abundance during the deposit of this bed, but they were strictly confined to this series." Here are two assertions for which there is not the least proof; first—that these fossils indicate the first conditions of life upon the globe; and second—that they were strictly confined to this series. Again, he says, "Vegetable life was then introduced, but, with the exception of a few scorpions and shells, no terrestrial or fresh-water animals existed; so that while the sea was the habitation of fishes of considerable magnitude and high organization, on land there only existed vegetable life in abundance, and no highly organized animal appeared to have been introduced. After the deposit of coal, the sea became less fitted for the larger fishes; reptiles then began to be introduced, and the land became adapted for the different kinds of vegetation. As time wore on, however, shell-fish of every kind, one after another, became abundant, and died away, and the nautilus and cuttle-fish reigned undisputed lords of the deep.

"But the chaos on land, and the reign of these animals also, approached their termination, and fishes of a higher organization made their appearance. In the first instance they were small and powerless, but soon increased in size and proportion. These were succeeded by animals of a stronger, healthier, and more vigorous constitution. While these changes were proceeding in the sea, the land was attaining a more perfect adaptation, becoming a more appropriate residence of animals. At this period the reptiles appeared."*

These directly opposite opinions, held by such eminent geologists, on the most important questions connected with this science, must necessarily perplex the young geological student, and weaken his confidence in modern theories. They are also calculated to hold in contempt those who denounce the Mosaic narrative as a vulgar error, on no better authority than that of modern philosophers, whose doctrines are as much opposed to each other, as to the obvious meaning of the Sacred Volume.

Linnæus imagined the habitable world to have been for a certain time limited to one small tract, the only portion of the earth's surface that was, as yet, laid bare by the subsidence of the primæval ocean. In this fertile spot he supposed the originals of all plants which existed on this globe, to have been congregated, together with the first ancestors of all animals, and the human race. He supposes this to be in some warm region, but to have contained a lofty mountain-range, on the heights and declivities of which were to be found all temperatures, and every climate from the torrid to the frigid zone. "But without dwelling on the above and other refuted theories," says Lyell, "let us inquire whether some hypothesis cannot be substituted as simple as that of Linnæus, to which the phenomenon now ascribed in regard to the distribution both of aquatic and terrestrial species may be referred. The following may, perhaps, be reconcileable with known facts. Each species may have its origin in a single pair, or individual, where an individual was sufficient, and species may have been created in succession at such times, and in such places, as to enable them to endure for an appointed period, and occupy an appointed space on the globe."

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* The lecturer closed the address from which these extracts have been made, with the distinct intimation that "the work was progressing; that the earth was shortly to receive upon it another series of a higher organization, of greater physical powers, and better fitted for the future condition of existence."—Geological Lectures, June, 1846.

" In order to explain this theory, let us suppose every living thing to be destroyed in the western hemisphere, both on land and in the ocean, and permission to be given to man to people this great desert, by transplanting into it animals and plants from the eastern hemisphere; a strict prohibition being enforced against introducing two original stocks of the same species."

" Now, it is easy to show the result of such a mode of colonizing would correspond exactly, so far as regards the grouping of animals and plants, with that now observed throughout the globe. In the first place, it would be necessary for naturalists to study the climate and other physical conditions of each spot, before they imported species into particular localities. It would be no less requisite to introduce the different species in succession, so that each plant and animal might have time and opportunity to multiply, before the species, destined to prey upon it, was admitted. Many herbs, for example, must spread far and wide, before the sheep, deer, and goat could be allowed to enter, lest they should devour and annihilate the original stocks of many plants, and then perish for want of food. These should, in their turn, be permitted to make considerable progress, before the entrance of the first pair of wolves or lions. Insects should swarm before the swallow could be permitted to skim through the air, and feast on thousands at one repast." He goes on to show, however equally the original stocks were distributed, there would, in time, arise distinct botanical and zoological provinces; and that, finally, things would be as they are at present; and thence concludes, that as the successive introduction of new species into the western hemisphere would produce results analogous to those which now exist; therefore, the existing order of things must have been produced by the successive introduction of new species. Elsewhere he states, that " from the remotest periods there has been ever a coming-in of new organic forms, and an extinction of those that pre-existed on the earth, some species having endured for a longer, others for a shorter, period of time; but none having reappeared after once dying out."*

The theory of Linnæus is objectionable, but that of Lyell is more so. In the first place, it is opposed to Scripture: the doctrine of successive creations of new and distinct forms of organic beings, is incompatible with God's rest on the seventh day, which intimates the termination of all new forms of creation. Secondly—it is repugnant to the idea we should form of an All-wise and All-powerful Creator. A Being who foresees all the possible circumstances which can arise in relation to his creatures from the physical constitution of this world, is not obliged to await such circumstances, in order to produce creatures suited to them. No; the Almighty formed, at once, perfect systems in the animal, vegetable, and mineral worlds, as well as in that wonderful department of creation which astronomy unfolds to our view. He adapted the different classes of creatures to all those exigencies which, in his fore-knowledge, they should have to encounter; and although many of those which were at first created, have since passed away, it is only what had been pre-ordained by the All-wise Creator.

Their disappearance from the face of the earth, has left blanks in the system, and broken links in the chain which binds creation together, but they have caused no derangement of the general order, nor in the Creator's plans. As a vine pruned becomes more fruitful and vigorous, so the extinction of some species has contributed to the general welfare. Bears and lions once occupied those regions which man now inhabits; and the marshes and forests which the extinct races once occupied, are now the retreats of species more useful to man.

Extinct animals had fulfilled the object of their creation, and disappeared from the face of the earth. They formed a portion of one great system, and were withdrawn when they were no longer necessary for the fulfilment of the great objects of creation.

But what were those great objects which could have made their presence necessary at one time, and not at another? Lyell's illustrative example in peopling the western hemisphere, will assist in explaining this query. "The sheep, the deer, and the goat," he writes, "should be allowed to make considerable progress, before the entrance of the first pair of wolves and lions." This we would readily grant, had there been no other mode of preserving the herbaceous animals, and of feeding the carnivorous. But, because there were no successive creations, and the sheep, deer, goat, and other useful animals should be permitted to live, it became absolutely necessary that a far greater number of species should have been at first created. By this means, the carnivorous races were supplied with food, but some of the herbaceous species became extinct, before those which survived were sufficiently multiplied to supply their places, and prevent the danger of total extinction.

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* Elements of Geology, p. 275.

It must, however, be observed, that we do not affirm that all the extinct species perished by this means. No; some of them were as checks and counterchecks to other races, and perished various ways, as will be noticed hereafter. In the mean time, we must remark, that the creation of a greater number of species than are now in existence, displays more wisdom than the plan of the successive creations, and involves no absurdities, as the other evidently does; for if carnivorous races could not have been introduced, until those species upon which they prey had been sufficiently multiplied, we should have insects long anterior to fishes and birds, as both these latter prey upon the former. Fishes should precede the feathered tribe, that aquatic birds may have an abundant supply of food; and, as several orders of insects live upon flesh, even upon the living flesh of beasts and birds, then beasts and birds should have been anterior to insects. Following out this theory, we would have insects preceding fishes; fishes, birds; and birds, insects. Linnæus' theory was possible though improbable; Lyell's impossible and extravagant; but that of Moses is not only rational, but in strict accordance with the existing system of nature.

The mutual dependence of these animals on each other, makes it evident, that they not only formed one system, but that the different classes of creatures are coeval. Extinct species of plants and animals can be shown to form portions of the respective species to which they belong; but no geologist has dared to assert, that any class of extinct organic beings, or even all of them together, formed any system distinct from those which now exist. The four great divisions of animated nature, viz., fishes, birds, beasts, and insects, are so connected with each other, that no class could precede the others by any length of time; besides, no class could subsist without the others, and this mutual dependence renders the existence of regular systems necessary at all periods of time; and hence, no distinct genus or order of creatures could at all have existed for any long period independently of others.

" If," writes Lyell, " the polar bear were introduced into Iceland, the deer, foxes, seals, and even birds on which these animals feed, would soon be thinned down. The plants on which the deer feed being less consumed, would soon supply food for insects. The increase of these would furnish other insects and birds with food. The diminution of seals would afford a respite to some fish, and these fish, in their turn, would multiply, and press upon their peculiar prey. Many water-fowls, the eggs and young of which are devoured by foxes, would increase, and the fish upon which the water-fowls subsisted, would then, in their turn, be less numerous. Thus, the numerical proportions of a great number of the inhabitants of the land and sea might be permanently altered by the settling of one new species in the region, and the changes caused indirectly would ramify through all the classes of the living creation, and be almost endless."*

Lyell thus helps to demonstrate the mutual dependence of animals on each other, and to prove that no distinct races could exist, unless they constituted perfect systems.

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* Geology, book iii, p. 125.

But as no geologist attempts to prove that extinct animals formed such systems, it follows that they must have belonged to the existing races, and were but links in the chain which unites all together. This theory, also, goes to prove that species have not been successively introduced to suit the varying conditions of the earth, and, consequently, refutes the doctrine of successive creations of organic beings.

"The introduction of only *one* new species," he says, "would ramify through all classes of living creatures, and be almost endless. The introduction of the polar bear would diminish the number of seals, and this would be calculated to *increase* the number of fishes. It would also diminish the number of foxes; this would tend to increase the water-fowls, and, consequently, to *diminish* the number of fishes. Now, as the increase and decrease of different species of fish may be very disproportionate, another species of creature should be introduced to preserve the balance of power,* and this again would cause another series of ramifications "through all living creatures, and be almost endless." Indeed, this mode of proceeding would produce an endless number of ramifications, and be, not *almost*, but altogether endless.

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* Wilcke says that every plant has its proper insect allotted to it, to curb its luxuriancy, and to prevent it from multiplying to the exclusion of others; and these insects are kept down by others, and these again by parasites expressly appointed to prey upon them. Insects multiply so rapidly and so amazingly, that a few individuals, in a very short time, will give birth to myriads. "But," says Lyell, "no sooner has the destroying commission been executed, than the gigantic power becomes dormant, the mighty host soon reaches the term of its transient existence."

Reaumur has proved that an aphis may be the progenitor of 23,619,600,000 descendants in a year. Were this to continue unchecked for a few years, their numbers would be prodigious. How unseasonably would a new species be then introduced to check their future progress when they had multiplied to some amazing extent! To repress the monopoly of every species, in a well-ordered system, the checks and counterchecks should be coeval with their victims. This is what exists at present, and what ought to exist at all periods; nor is there any reason to suppose the Almighty at any former time adopted any other mode. The idea, therefore, of introducing new species from time to time, is contrary to the existing order, inconvenient in its results, and ill calculated to support a system in which no defect, no imperfection should exist.

The destruction of the deer would be attended by an increase of insects; this would multiply other species, and bring into the country new flocks of birds; then, of course, new checks and counterchecks should be admitted; and if the introduction of *one* new species " would ramify through all classes of living creatures," what are we to imagine would result from the introduction of many species, not only in the different departments of zoology, but in the different regions of the earth! Such a plan would be imperfect, inconvenient, inconsistent with the wisdom of the Creator, and would form no system, but a medley, in which all the parts united to produce the greater disorder.

Were it necessary to introduce a new species which had not previously existed, whenever the physical geography of any country was materially altered, then it would be equally necessary to introduce other species, either as food for the former, or to check their growing numbers; other checks and counterchecks would then be required; and, as Lyell remarks, the influence of these would either ramify through all the pre-existing races, or the newly-created species should form a perfect system. But to form such a system, all classes of animals should be included. We would, in this case, have very strange anomalies: perfect systems newly created, and portions of older systems hastening to decay, occupying the earth together; or, old systems patched up of new species different from those whose place they occupied, and only calculated to produce the utmost disorder in the organic kingdoms. Besides, as extraordinary changes in physical geography may occur simultaneously in different regions of the earth, the creatures introduced should be of such a nature as to harmonize; and were the changes of the earth's surface frequent, the frequent introduction of new creatures would be necessary. The whole organic creation would be then the mere subject of circumstances. Revolutions in the physical world, and not the fixed laws which the book of

Genesis prescribes, should govern animated nature; a result which no one should ascribe to Infinite Wisdom.

How different are the ways of God from man's erroneous notions! how different from geological chimeras has been the Creator's arrangement of the organic kingdoms! Animals were created at first with habits suited to the climates in which they were placed, and endued with powers or capabilities of sustaining changes in food and climate to certain extents, varying in different orders in greater or less amounts; and hence, we perceive the same species, nay, the same variety or individual, not only enjoying our mildest summers, and living through our severest winters, but thriving in regions quite different from those they had previously inhabited.

In cases which require a still more wonderful interposition of Providence, the Creator has provided for the safety of some species by contrivances so admirable, that all who are not wilfully blind, must see that God had no intention of forming new beings suited to the varying conditions of the globe, having fitted the old for all the changes which could possibly occur in the order of those he had established.

The surprising powers of locomotion which birds of passage possess, were given them to migrate to distant regions when scarcity of food or severity of climate renders a change of locality absolutely necessary. This would have been needless had the doctrine of successive creations been true. The transformations which insects undergo, are striking manifestations of that power by which creatures are preserved amid the changes of season and the variations of climate. The metamorphoses they undergo are a manifest proof that nature has provided for their safety, whatever be the vicissitudes which occur in the physical world; and that no new created being could be better adapted to the altered circumstances arising from season or climate, than these are in the new forms they assume. The aurelian condition of these creatures enables them to outlive seasons which in their insect state they could never have survived; seasons which would annihilate every new form of insect that might be introduced, were they incapable of changing their forms.

Animals which lie dormant in winter, form another class which Providence preserves from perishing at times when food could not be procured. Had these been left to perish, others might be created to occupy their places, were successive creations the means adopted by God to continue the animal race upon earth.

Whenever any unusual changes in the physical geography of a country occur, certain species may indeed perish, but others are found in some adjacent district to take their place. Sometimes, because the depopulated tracts may be congenial to their natures; sometimes, because a species, unchecked by foes, may have multiplied too much for the regions they had before occupied; and sometimes, because the former abodes of some, may have been invaded by other species. Thus, a locality, whose former inhabitants had perished, may again be tenanted by new settlers, with their checks and counterchecks, without the creation of any new species.

That certain species, like individuals, perish by gradual decay, is an opinion which has not been confirmed by fact. The limited range of some species may expose them to destruction by foes, by sudden inundations, or by considerable changes in the physical geography of a country; but without such extraordinary causes, no species could perish, as none come into existence without parentage. No extinct species can be shown to have perished by gradual decay, for in all the cases wherein they have disappeared from the face of the earth, sufficient causes to produce such effects, have actually existed.

If the conflicting theories, noticed in this chapter, be data for arguments and conclusions, it will, indeed, be difficult to determine what opinions are untenable. Were these theories a portion of one system, in which every part, either directly or indirectly, tended to increase our confidence in the whole, they never could have been so hostile to one another. But, doctrines framed in opposition to Scripture truths, carry with them the impress of error. Scientific truths are facts; and Scripture truths are stamped with the authority of inspiration; hence, science, truly such, can never be opposed to revelation.

The sentiments and opinions of the true philosopher, in every department of science and literature, should be conformable to the doctrines revealed by Infinite Wisdom. The ideal successive creations of organic species, and the constant introduction of new orders of creatures without parentage, must be regarded as opinions in many ways highly objectionable. They are hostile to Scripture, as the Creator ceased from producing any new form of organic beings on the seventh day; opposed to fact, as it cannot be shown that any single species has been introduced upon earth within the historic period; and contrary to the existing order of creation, as the introduction of any new species would derange the present system, by affecting all other orders of creatures. Successive creations would be unnecessary, as regards the balance of power to be maintained amongst species; imperfect, as creatures incapable of sustaining changes of season or climate in one state of existence, should be endued with powers of assuming other forms, suited to the altered circumstances of country and climate; and needless, as regards the re-occupation of depopulated localities. In fine, such creations would be derogatory to the Wisdom and Power of the Creator, who, certainly, was not ignorant of the changes which were to take place in the physical condition of the globe, or unable to endue his creatures with powers capable of sustaining the effects of such changes. In a word, the laws of God and the laws of nature are opposed to these theories, and yet, they are the theories of the pseudo-philosophers of the nineteenth century! How can we blame the early geologists for their extravagancies?

CHAPTER XVIII.

Distinct creations should constitute distinct systems—Extinct species, a portion of the existing system—Divisions of the animal kingdom—Connexion of organic beings—Links between the vegetable kingdoms—Links between plants and animals—Kingdoms of creation form perfect systems—Minerals, (note)—Ultimate elements of vegetables—Elements common to different bodies—Jussieuian system—Extinct and existing plants, one creation—System of MacLay and Swainson—Class of mammalia—Edentates and pachydermata—Extinct monsters named after modern geologists—Low antiquity of man—Extinct animals and man, co-eval—Examples—Grotto of San-Ciro—Fossils in Australia—Inconsistency of geologists, &c.

Were extinct organic beings unconnected with existing orders, they should form distinct systems. No geologist has attempted to form such systems from the fossils of the secondary and tertiary strata. If, on the other hand, extinct species only fill up gaps in the existing system, if they are but links that bind together the present races, it will evidently follow, that all belong to one creation, that all form but one system, and that there have been neither distinct creations nor successive introductions of new species.

The animal kingdom is divided into *classes* or *sub-kingdoms;* these are composed of many *orders;* orders consist of various *families*, and these again of numerous *genera;* each genus is divided into *species;* and species are composed of numerous *varieties*. The other kingdoms of creation are similarly divided.

Beings of the most simple organization, as well as those among the highest in the scale, are found in each of the sub-kingdoms. In the sub-divisions of each class, various points of approximation occur. Like the colours of the rainbow, or the meshes of net-work, they glide so insensibly into each other, that the link which joins the preceding with that which follows, seems equally to belong to both. Even the distinct kingdoms pass into each other, so as to make it sometimes difficult to determine to which kingdom the connecting link belongs.

Plants are intermediate between animals and minerals. The mineral and vegetable kingdoms have many points of contact: coal and asbestos are examples of this union. *Elastic asbestos, rock-cork, ligniform asbestos,* or *rock-wood,* the *amianthus,* or *stony-flower,* are species of this mineral, whose names seem to indicate its connecting properties. From one of the varieties of this mineral, the ancients made a kind of cloth remarkable for its singular property of incombustibility. The amianthus, in its external form and qualities, links plants and minerals; while coal, by its approach to the most valuable of minerals on one side, and to wood on the other, seems another link in the connecting series.

Plants and animals are bound by links of a more strange character. They seem to blend into each other in the class of zoophytes, in such a way as to make it difficult to determine the point at which one kingdom begins, and the other terminates. Both may be said to diverge from a common point, forming in their onward progress, groups of creatures, so dissimilar, that no one, ignorant of the links which bind them, could imagine that existences so unlike, could have the most remote connexion.

We will not usurp the province of the botanist or naturalist by lengthened dissertations on vegetable physiology or natural history; a few examples, sufficient to establish inductively the connective union subsisting between the different parts of the material world, shall engage us at present.

It will equally appear from the systems of Tournefort or Jussieu, in botany, and from those of Linnæus or Cuvier, in zoology, that these kingdoms are composed of parts so connected with each other, as to form perfect systems. In botany, whether we regard the structure, the form, the properties, or the substance of plants, this connexion will be equally observable.* And notwithstanding " the variety of aspects under which vegetable sub-

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* As the composition and properties of minerals are, perhaps, less known to the general class of readers than those of the vegetable

kingdom, it may be interesting to many that we notice more in detail, the connexion of minerals with each other, in substance, form, and quality.

The diamond, the hardest and most beautiful of minerals, approaches, in *external* character, so closely to the *zircon* and *hyacinth*, as frequently to be mistaken for these minerals; while in substance it is almost identical with anthracite coal, being carbon in its purest state.

The *garnet* family resembles the zircon and hyacinth, not only in external qualities, but in the substances which compose them, each family containing in common, *alumina*, *silica*, *magnesia*, *lime*, *iron-oxide*, and *potash*.

The *ruby*, the *topaz*, the *schorl*, the *quartz*, and all the other families of crystals, glide into each other by external form, as well as by the other properties which distinguish the different species.

The *Bristol* and *Cornish diamonds*, the *brown* and *yellow crystals* of Cairngorm in Scotland, the *amethyst*, the *rose-quartz*, the *green-quartz*, *cornelian*, *opal*, *onyx*, and several others, are chiefly composed of silica, differently tinged by its union with other bodies; while the *caylamite*, *spinel*, *sapphire*, *emery*, *corundum*, and *adamantine-spar* are composed principally of *alumina*, with some silica, magnesia, and iron-oxide. These are also the chief constituents of *obsidian*, *pitchstone*, *pumice*, and a great variety of others, too numerous to be noticed.

Feldspathic and *hornblendic* rocks appear to be the extremes of two series of rocks, which graduate into each other by innumerable variations. Dr. Ware has noticed a gradation from *binary granite* to *basaltic rock*. "The granite of the Alps, north of Como, is seen to pass, by an easy gradation, first to *common sienite*, then to *sienite-hypersthene*, some of which has *white felspar* and *black hypersthene*, and *greenish felspar*." Some hypersthene-sienite passes into common sienite, and often cannot be distinguished from *diallage rock* or *greenstone*.

Dr. M‘Culloch tells us that the granites of Aberdeenshire are generally composed of quartz, felspar, and mica; that hornblende is sometimes substituted for mica; that the quartz sometimes fails, and that this hornblendic mass becomes finally grained, and passes to greenstone, basalt, and an earthy trap-like claystone. Von Deehen expresses the opinion of geological observers as to the gradation in character from one to another in all the igneous rocks, as that granite, by replacement of its mica with hornblende, changes to sienite; by containing detached felspar-crystal it becomes porphyritic. Sienite and felspar-porphyry pass to greenstone or traps. The absence of felspar turns certain greenstone to hornblende rocks, and augite, instead of hornblende, produces a new variety, which easily passes to basalt.

In fact, these rocks are so nearly connected, that the change of a single ingredient, or even the variation of quantity or arrangement, produces a new series; and yet, because cases exist in which rocks of very different character pass into each other, as sienite into limestone, stances are presented to us, and the striking differences of their properties, they are all composed of four ultimate

geologists infer the once-liquid state of the former, and the change as having been produced by the contact of limestone with liquid igneous matter. The limestone in contact with igneous rock in the Isle of Skye loses all stratification, and appears a pure white marble, of fine grain; and closer to the sienite, it is overloaded with silica, magnesia, and argil. Veins or nodules of greenish transparent serpentine, intermixed with pure carbonate of lime, are the constituents of the rock of both series.

Granite may be connected with lava by a series of gradations, while, on the other hand, a different series unites it with the stratified formations. Limestone passes to a pure white marble; chalk passes into granular marble. At one extreme we find a dark brown crystalline limestone, then the saccharine form, again the grained and arenaceous state, which glides into a yellowish white, and finally graduates into unaltered chalk.

Granite gradually passes into *gneiss;* this into *mica-slate*, and mica-slate into *clay-slate.* Pure crystal glides into *chlorite-slate*, *talc-slate*, *whet-slate*, *drawing-slate*, aud *alum-slate;* and all these pass into each other. *Primitive limestone* is distinctly crystalline and transparent; it contains *quartz*, *mica*, *hornblende*, and many other minerals. It is sometimes stratified and sometimes not. The crystalline texture gradually becomes less and less distinct as the formations advance, till at last the limestone assumes the appearance of an earthy deposit.

Basalt is sometimes known to pass to *wacke*, sometimes to *greystone*, and sometimes to *porphyry-slate;* while wacke often graduates into clay. The gradations by which the various *sandstones* and *conglomerates* pass into each other, are no less remarkable.

Examples without limit exist to show that all the families of rocks and earths insensibly glide into each other, and that no link is wanting in the chain that binds the compound minerals together. "In nature there is every intermediate gradation, from perfectly loose sand to the hardest sandstone;" and from the softest clay to the most compact granite; and in whole masses of strata this gradation is visible. "After examining," says Lyell, vol. iv, p. 89, "the whole line of coast of Essex, Suffolk, and Norfolk, I found it impossible to draw any line of separation between the different groups of strata; each seemed in its turn to pass into another."

Thus, it appears that all minerals are connected like net-work, and constitute one system. This kingdom, by links still more wonderful, glides into the animal and vegetable kingdoms; and these kingdoms form perfect systems, in which no blanks existed when coming from the hands of the Creator. If links are now wanting in these, the gaps have been made by natural causes, and may be filled up by the extinct races which really form a portion of the existing organic systems. Distinct creations and new successive species had no existence save in the imaginations of persons unwilling to seek a more religious and rational solution of the difficulties involved in the useful but misapplied science of geology.

elements, but the combinations into which these enter are almost infinite; and each form of combination produces a substance of a different kind. These substances, associated more or less numerously with each other, compose the vegetable structure; and, being the more immediate object of sense, in the investigation of any organization, they are called their *proximate principles.* Existing ready-formed in woods, roots, leaves, flowers, and seeds, we find a considerable number of principles, as acids, alkalies, sweet principles, bitter principles, oils, exudations, some poisonous, others wholesome."*

Wood, hemp, gum, sugar, starch, and several other vegetable substances, are composed of the same identical elements; and the carbon, oxygen, and hydrogen which at one time constitute wood, may, in the hand of an ordinary chemist, be the carbon, oxygen, and hydrogen, which at another time form gum or sugar. What seems still more surprising is, that potash and ammonia are found in each one of the three kingdoms of nature, and, in many respects, resemble each other; and though *lithia* is exclusively of mineral origin, yet chemists have proved it to be of the same constitution as potash and soda; and thus we find, that as far as *substance* is concerned, the subdivisions of the vegetable kingdom *do* graduate into each other.

In reference to the system of Jussieu, Mr. Chambers says, " It is well known that there are many genera which stand on the confines of two orders, with neither of which they exactly agree." In such cases, uniting the neutral with one or other of the more decidedly-marked orders, would surely be better than constituting a new order, merely for the purpose of more completely or scientifically identifying the one unsociable plant.

Professor Lindley, in speaking of the extinct *lepidodendron,* says, " To botanists this discovery is of very high interest, as it proves that those systematists are right who contend for the possibility of certain chasms now existing between the gradations of organization, being caused by the extinction of genera or even of whole orders, the existence of which are necessary to complete the harmony which it is believed originally existed in the structure of all parts of the vegetable kingdom. By means of the *lepidodendron* a better passage is established from flowering to flowerless plants, than by either the *equisetum* or *cycas*, or any other known genus."

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* Donovan's Chemistry, p. 272.

That system of nature first noticed, perhaps, by MacLay, and further developed by Swainson, fills up those gaps in the animal kingdom, with those forms disclosed by geology. We cannot enter into this part of our subject so much in detail, as to assign each fossil its place in the existing system; our limits will only allow us to give such examples as will tend to demonstrate that extinct species once constituted portions of that reticulated system of animated beings, which had been perfect in all its parts when coming from the hands of the Creator.

The *ungulata*, or hoofed animals, form one of the *orders* into which the class *mammalia* is divided. The order is divided into five families, namely, the *solipedes*, the type of which is the horse; the *ruminantia*, the type of which is the ox; the third family consists in part, perhaps chiefly, of animals known to us only by their fossil remains, and are called the *anaplotheres;* the fourth, the *pachydermata*, which comprise the elephant and rhinoceros; and the fifth, the *edentates*, comprising the sloth and anteater.

There is every reason for supposing this group to be natural. The *solipedes* graduate into the *ruminants* by the camel, whose foot resembles that of the horse, and ruminating structure, that of the ox. The tapir presents an intermediate form between the ruminants and the armadillo, and connects the anaplotheres with the edentates. The sloth, placed by Cuvier among the latter, leads immediately to the fossil genus, *megatherium*, in the circle of the *pachydermata;* and we return again to the solipedes by means of the hippopotamus.

Here the fossil genus, *megatherium*, forms the link between the edentates and pachydermata; and without this most singular link of connexion, it would be difficult to conceive in what manner animals so huge could have been united with the sloth. We say, in the words of Swainson, " the discovery of this animal, in short, sets at rest the scruples of those who have imagined that extinct animals formed no part of the circular plan pursued in the creation of existing races."

The wonderful economy of nature renders such a system in some measure necessary; and that this system should be the result of one creation, seems also required, as there is no race of animals now in existence which could live independently of all others. As there is not now a single species which stands isolated from all others, there is no reason to suppose that any such has ever existed, and if not, extinct races should constitute a part of the present system. They do not form systems by themselves, and hence, those by gone races which geologists suppose to have roamed this earth myriads of years before man was created, are, in truth, the counterpart of those that live at present. Modern geologists may be complimented by giving their own names to extinct monsters: it is, however, certain that the *Iguanodon Mantelli*, the *Cephalaspis Lyellii*, or the *Megalosaurus Bucklandi*, had not an earlier origin than the common whale, the crocodile, or the hippopotamus.

The Scripture narrative determines the origin of man, and on this point geologists, for the most part, admit its authority. From this fixed era they prove the high antiquity of extinct animals by such arguments as the following: " In none of these formations," says Sir H. Davy, " whether called secondary, tertiary, or diluvial, have the remains of man, or any of his works, been discovered." " No conclusion is more fully established," exclaims Lyell, " than the important fact of the total absence of any vestiges of the human species throughout the entire series of geological formations. Edifices, and even entire cities, have, within the times of history, been buried under volcanic ejections, submerged beneath the sea, or engulfed by earthquakes; and had these catastrophes been repeated throughout an indefinite lapse of ages, the high antiquity of man would have been inscribed in far more legible characters on the frame-work of the globe, than are the forms of the ancient vegetation which once covered the islands of the northern oceans; or of those gigantic reptiles which, at still later periods, peopled the seas and rivers of the northern hemisphere."*

Dr. Buckland asserts, that "had the fact been otherwise, there would, indeed, have been great difficulty in reconciling the early and extended periods which have been assigned to the extinct races of animals, with our received chronology. On the other hand, the fact of no human remains having been yet found in conjunction with those of extinct animals, may be alleged in confirmation of the hypothesis, that these animals lived and died before the creation of man."†

In reference to the antiquity of man, it may be observed, that were there no proofs of his origin but those which geology supplies, our history of him would be as vague and uncertain as the fables of the most barbarous nations. And judging of the geological epochs of plants and animals by what this tells us of man, we cannot but feel the unfavourable position in which the analogy places geological theories. We have no desire to trace the antiquity of man through "the indefinite lapse of ages;" our object is to show, that geology furnishes no proofs that even plants or animals have endured so long.

Dr. Buckland concludes, that extinct animals lived and died before the creation of man, because no human remains have been discovered in conjunction with those of ancient animals. This is certainly a most illogical conclusion. In the first place, he gives no geological proof of man's origin, and yet, he infers the high antiquity of extinct races by this creation; secondly, he supposes the fossils of man and beast should have been found together, had they been coeval. It may be just to expect to find such remains together in some instances; but it is certainly unjust to infer the high antiquity of one, and the low antiquity of the other, because human fossils have not been found in strata which contain those of extinct animals. The high antiquity of extinct animals is, in fact, a gratuitous assumption, as it cannot be shown by geological evidence that these were anterior to man. The following circumstances are calculated to prove them coeval, rather than to show the comparatively recent creation of man. The bones of the hyena, tiger, elephant, &c., have been found in the Kirkdale cave, Yorkshire. Geologists infer from this, that those animals were indigenous to England; that the climate of England was then what the tropical regions are at present, and that this state of things existed long before the creation of man. This supposed change of climate, secondary and tertiary fossils, geological epochs, &c., will be found on strict examination to be as the delusive *mirage* to the parched traveller of the desert.

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* Geology, vol. i, p. 157.

† Geology, vol. i, p. 18.

" Dr. Schmerling has found in several caverns on the banks of the Meuse, near Liege, *human bones* in the same mud and breccia with those of the elephant, rhinoceros, bear, and other quadrupeds of extinct species." Is not this evident *geological proof* that quadrupeds have become extinct since man's appearance on the globe; and that the elephant, bear, rhinoceros, &c., frequented the banks of the Meuse, within the historic period? If these animals roamed at large where Liege now stands, why should we deem an extraordinary change of the climate of England necessary to account for the contents of the Kirkdale cavern?

In the cavern of Bize, in the department of Aude, human bones, mixed with those of *extinct animals,* and with land-shells, have been found by M. de Serres. This is another geological proof that *extinct animals* and man were inhabitants of France at the same period. " In the same caverns several human teeth, broken fragments of rude pottery, and recent* marine and terrestrial shells, have been found." Here are *recent* shells, *human* teeth, *rude pottery,* and the remains of *extinct* animals, found together. Were they not coeval?

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* Geologists apply the term "*recent*" to shells, animals, &c., of the existing species, in contradistinction to the term " ancient," applied to extinct species.

"Also, in the same mass were found the bones of three *new species* of deer, an extinct bear, and the wild bull, formerly a native of Germany." This fact proves that species have become extinct in Germany within the historic period.

"M. de Christal has found in caverns in tertiary limestone, at Pondros and Souvignargues, in the department of Herault, human bones and pottery, confusedly mixed with remains of the rhinoceros, bear, hyena, and other terrestrial mammifers. They were embedded in alluvial mud, of the solidity of calcareous tufa, and containing some flint, pebbles, and fragments of the indigenous limestone. Beneath this mixed accumulation, which is sometimes thirteen feet thick, is the original floor of the cavern, covered with the bones of animals. The human bones were found, upon careful analysis, to have parted with their animal matter, to as great a degree as those of the hyena which accompany them." If the rhinoceros and hyena were natives of Herault, it must be admitted that this has been since man became an inhabitant of the country. If these animals were not natives of France, but introduced by the ancient Romans to entertain the people at some of their public shows, in which the murdered slaves and slaughtered animals might have one common grave; then their fossils afford no proof that the climate of France has undergone any change. In either case, whether they were natives of France or not, geologists can deduce no argument in favour of change of climates, in proof of the high antiquity of extinct animals. The same argument holds good respecting those fossils of the Kirkdale cavern, as England was subject to Rome as well as France, and as many are of opinion that both countries were formerly united. In one case, some barbarous show might have supplied the fossils of the Kirkdale cavern; and in the other case, the animals common to France might also have been common to England. In any case, these fossils prove no extraordinary change in the climate of England.

We are told by Hoffman, that the mammoth, and an extinct species of hippopotamus, have been discovered in the stalactite of caves near Sortino; and that a breccia, containing the bones of an extinct rhinoceros and hippopotamus, has been found in a cave near Syracuse; and the whole mass covered by a deposit of marine clay, filled with *recent* shells. " The association in these shells of living species," writes Lyell, " with the remains of extinct mammalia, is very distinct, and shows that the longevity of species in the mammalia is inferior to that of the testacea."

The association of recent shells with the remains of extinct mammalia, evidently proves the extinct animals not to have been anterior to living species. Lyell, however, wrests this fact, to establish his favourite theory, namely, the successive introduction of new species, and the gradual decay of the old. Here two inferences may be drawn from the same fact, one harmonising with Scripture, and the other directly opposed to it. Though the former is manifestly the more just and natural conclusion, yet geologists prefer the latter, perhaps because it is less simple, and more favourable to their theories.

"Within the grotto of San-Ciro such a quantity of bones were found, that many shiploads were exported in 1829 and 1830. The bones belong chiefly to the mammoth, and with them are those of the hippopotamus, *distinct from recent species;* those of the deer and bear were also discovered." As no such quantity of bones could have been collected in one place by any accidental means, nor without the aid of man, it follows, that those remains, which geologists refer to species long extinct before man's appearance on earth, were, nevertheless, actually collected by man, and probably belonged to animals sacrificed by the superstition or cruelty of the ancient pagan Romans, as vast numbers were slain in the amphitheatres, erected in different parts of the empire as well as in Rome. These circumstances show what little confidence can be placed in geological theories.

"In the cavernous limestone of Australia, the remains of the fossil mammalia are found, referable to species now living in that country, mingled with the relics of extinct animals." This fact proves, first—that living species existed contemporaneously with extinct races; secondly—that limestone, containing organic remains, could have been formed within the period termed "recent" by geologists, that is, since the creation of man. How they can assert that species have become extinct in a country whose living species are so little known, is somewhat strange. They may have been unknown relics or the remains of *unknown animals*, but to affirm them at once the relics of *extinct races*, is outstepping the limits which even geologists should claim.

With all this evidence, which actually demonstrates the co-existence of man and those extinct animals that geologists refer to remote eras, a favourite theory must still, at any risk, be maintained; and Lyell's attempts to support it, in direct opposition to the facts which he himself enumerates,* are very futile. "It is not," he states, "on the evidence of such intermixtures that we ought readily to admit either the high antiquity of the human race, or the recent date of certain lost species of quadrupeds."

This is very strange: the remains discovered in the Kirkdale cavern, are triumphantly paraded by geologists as a proof that England once enjoyed a tropical climate, though all the facts of astronomy are opposed to this opinion. The bones are referred to animals said to have inhabited this island long anterior to the creation of man. But when human bones are found in connexion with similar remains elsewhere, then the evidence, forsooth, cannot be admitted as regards man. If such remains serve to determine the high antiquity of extinct races, will not the same evidences also apply in proof of the high antiquity of man, or, indeed, to speak more truly, are they not triumphant evidence of the low antiquity of the extinct races? The presence of human bones, of marine testacea, and the remains of extinct animals in the same mass, is evident proof that the deposits were contemporaneous, and the animals co-existent. At all events, whatever is admitted in one case, cannot, consistently, be rejected in the other. These facts afford additional geological proofs of the truth of the Mosaic account of the creation; and we do not hesitate to assert, that correct interpretations of all geological phenomena will tend to confirm the Scripture narrative, and "increase the sum of our proofs in favour of Christianity."

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* Geology, book iii, c. 14.

CHAPTER XIX.

Scripture, the basis of true philosophy—Third day's creation—Effects of the sun on the fourth day—Condition of the earth after the six days' work—Effects produced by rivers—Sources of rivers—Danube—London and Paris basins—Nile—Ganges—Mississippi—Canadian lakes—River basins—Early ages of the world, lakes, animals, &c.—Galapagos Island—Multiplication of species—How species may have perished—Formation of lakes—Interchanges of fresh and salt-water—Disappearance of species after the deluge—Extinct animals—Species which perished in the deluge—Fossils of extinct races—Antiquity of the earth not deducible from organic remains—Destruction of animal life by other causes—Examples—Sudden petrifaction of animal bodies—Objections to geological inferences—Different creatures at different depths in the ocean—Aqueous deposits—Shell-fish and animalcula—Where plants and animals may be present—Examples—Lithodomi or burrowing shells—Organic beings need parentage—Extraordinary vegetative powers of plants—Examples—Dispersion of animals—Rapid multiplication of species—Lake Laguna—Concluding remarks.

In adopting the literal meaning of the first chapter of Genesis as the basis of our opinions, we will not require from science a single sacrifice, nor shall we labour to invalidate the geological arguments of others, to make room for a new theory. Our object shall be to show, that all natural results arising from our hypothesis, are in strict accordance with the discoveries which geology has revealed; and shall thence conclude, by the indirect mode of demonstration, or, to speak in the language of philosophy, by the *reductio ad absurdum,* that our hypothesis is true and our data unobjectionable.

How long darkness brooded over the face of the abyss we have no possible means of determining. Whether long or short, is a matter merely conjectural. On the third day of creation, the dry land was made to appear, by an act of omnipotence no less wonderful than that by which it was subsequently covered with vegetables. These vegetables were adapted to the situation, the soils, and climates, which they occupied. But yet, there were no rivers, no fresh-water lakes, no springs, no fountains to water the earth. The ocean occupied its place, and its shores were unbroken by river-beds or ocean-currents. No estuaries, no wasted coasts were to be seen; and the amount of land and water was precisely that which the All-wise Being who formed them, knew to be necessary. This would, according to our hypothesis, or rather according to the obvious meaning of the first chapter of Genesis, have been the condition of things on the third day.

The influence of the sun and moon commenced with the morning of the fourth day; currents in the ocean and in the atmosphere, evaporation from the surface of the deep,* clouds, rain, snow, &c., followed, and water began to accumulate in lakes a few days subsequently; for there were no rivers to carry to the sea the surplus which remained when the animal and vegetable kingdoms were supplied.

The plants that first occupied the low lands and valleys in which these numerous lakes were then formed, were covered with the matter deposited by the water, and in the strata thus formed, the bodies of innumerable animals were embedded.† The torrents occasioned by the overflowing of these lakes, and the occasional bursting of the barriers which confined them, must have left considerable deposits of every description in plains over which they swept in their onward progress to the ocean. Where flows a river which had not to form its own channel, and to bear along in its course all the matter it had worn down?* The Nerbuddah in India has scooped out a channel in basaltic rock one hundred feet deep. The Moselle has worn the solid rock to the depth of six hundred feet. The valleys in the eastern Alps are cut through conglomerate six hundred or seven hundred feet deep. The cataract of Niagara has receded nearly fifty yards since the commencement of the present century; and below the falls it has hollowed out a channel one hundred and fifty feet deep, five hundred feet in breadth, and seven miles in length. Such examples may be multiplied without limit.

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* The Mediterranean yields in an ordinary day of twelve hours, a quantity of vapour equivalent to 5,280 million tons of water. The average quantity of water which falls upon Ireland in a day, is estimated by Sir R. Kane at 293 million cubic yards.

† If we drain a lake which has been fed by a small stream, we fre-

Almost all the rivers in the world have their sources in mountains, or elevated plains; for mountains, like all pointed bodies, diminish the electricity of the clouds, and produce rain. The higher the mountains, the greater the velocity of the descending water, and the more charged with the earthy matter worn down by its mechanical action on the strata over which it has flowed. We can state upon the authority of Sir George Staunton, that the Yellow River in China brings down in an hour 2,000,000

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quently find at the bottom, a series of deposits, disposed with considerable regularity, one above another; the uppermost, perhaps, may be a stratum of peat; next below, a more dense and solid variety of the same material; still lower, a bed of laminated shell-marl, alternating with peat or sand; and then other beds of marl, divided by layers of clay. Such strata are very remarkable in the estuaries of large rivers, as the Ganges, Mississippi, &c., and in valleys which may have been the bed of lakes or rivers." Lyell's Elements of Geology, p. 5. This example illustrates the principle, that "water is the best sorter of strata in nature," on account of the different specific gravities of bodies; but it militates against the geological theory of aqueous rock-formation, as we find this class of strata obeying some very different principle.

* For numerous examples of the frightful ravages caused by inundations, see Lyell's Geology, b. ii. The effects produced by ice and icebergs are also very remarkable. Scoresby counted five hundred icebergs drifting along in lat. 69° N., many of which contained strata of earth and stones, or were loaded with rocks, supposed to weigh from 50,000 to 100,000 tons.

cubic feet of earth. The amount brought down by the Ganges in a year, is estimated at seven hundred million cubic yards; and were we to estimate the ravages of other great rivers, especially before their beds were furrowed out, we should be the less surprised at any changes observable in the earth's crust.

Hungary, no doubt, once formed a vast lake, ere the Danube forced a passage through the Carpathian mountains. Even now, this mighty river seems to stand still in its course through that country. Its present bogs and marshes bear evidence of its former condition. The wide extended region of swamps, called the Lake of Xarayes, is formed by the floods of the Paraguay, notwithstanding the broad and deep channel which, at present, bears the waters of that river to the ocean. What must have been the state of the country ere the river-bed, which now drains this extensive region, was formed! What immense lakes must have been made by the numerous tributaries of the Amazon before the bed of that mighty river bore their united waters to the Atlantic! The history of rivers, their source, their origin, their progress, their beds, lakes, &c., would form no uninteresting portion of physical geography.

The islands in Cork Harbour, and the channel between Carlisle and Camden forts, together with the alluvial deposit on which the city is built, bear evident traces of the extensive lake which occupied this valley ere the waters of the Lee had forced a passage to the ocean. The alternate beds of peat and sea-sand to be found near Youghal, are evidences of the lake which the Black-water formed before Clay-castle was thrown up or the harbour made. The remarks of Mr. Murphy on the limestone country between Dublin and Slane, afford reason to believe that the basin of the Liffey was, at one time, a vast lake. "The surface soil of the extensive level," he says, "of which this rock forms the substratum, does not appear to have been formed by the disintegration of the subjacent rock, as between it and the surface a layer of gravel, or rounded stone intermixed with earth, occurs very generally; these round stones being, for the most part, a limestone of a much purer character, and suited for burning; but, rather, seems to have been deposited by the water of an immense lake, which probably, at some distant period, occupied this extensive flat."

The London and Paris basins, as well as several strata of the tertiary and secondary formations, owe their existence to similar causes. Had no rivers flowed through these basins, their strata would be very different from what they are at present. The accumulation of matter by the waters of the Seine, which flows through a valley of chalk in Normandy, and the probable submersion of this locality previous to the deluge, combined with the effects of that deluge, may account for the strata of this basin, and the organic remains which they contain, without the immeasurable periods which geologists deem necessary for their formation.

Innumerable facts, on record, show the effects of running water, but our limits will permit us to notice only a few. Lower Egypt is the gift of the Nile. The delta of this river is ninety miles from east to west, and the distance of its apex from the sea, a hundred. The isle of Pharos is now united to the continent, and seems to have been so at the time of the crusades. Tasso thus describes it:

> "By Pharos then they glide, an isle no more;
> An isthmus now projecting from the shore."

Though in the days of Homer it would appear to have been far distant from the land:

> "Thus steering backward from the Pharin isle,
> We gain the stream of Jove-descended Nile."

The delta of the Ganges, without including that of Burrampooter, is considerably more than double that of the Nile.

The delta of the Mississippi, and the swamps about New Orleans, indicate the former state of this region. The delta, with its drift-wood, shows the vast amount of matter brought down by the current, and the swamps are but the remnants of the former flooded state of this district, previous to the formation of the river-bed. The ravages of this mighty river must have been frightful; even now, notwithstanding its broad and deep channel, and the exertions of man to restrain it within limits,* these ravages are very considerable.

At seventeen miles to the north of St. Louis, the Mississippi receives the muddy and impetuous Missouri. It is a grand sight to see two such rivers uniting their waters. At the point of junction, you would suppose yourself in the midst of a lake; the banks disappear, as it were, in the presence of such a vast accumulation of water. Towards sunset the West appears an ocean into which the sun is about to sink. It is from that point the water comes, impetuous, whitish, and without limit. What must have been the state of this basin ere the channel of the Mississippi was formed to drain off this sea! "When you descend the Illinois, prairies on its right bank extend to its mouth in the Mississippi; but on the left bank, a chain of hills, seen in the distance, follows the windings of the river, and these border the Mississippi for the distance of eighteen miles. This grand calcareous formation presents, on the Illinois, rounded outlines, graceful figures, and pleasing coasts, covered with verdure and beautiful trees; but on the Mississippi it exhibits perpendicular bare walls, of a desolate aspect. The river, which evidently, in former times, *washed the very summit, and fashioned this shapeless mass*, has softened its angles, and given to its outlines the form of bastions and parapets. When you ascend the Mississippi above the Ohio, the banks are low and marshy, and covered with forests, devastated by an impetuous river, which carries away the stones, sand, clay, and trees; tears up, on the right, entire islands, to cast them on the left, after having overturned them; piles up trees wherever it meets an obstruction to its course; and displays, in fine, the grandest image of force, destruction, and chaos."

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* An embankment from five to thirty feet in height, has been raised for about one hundred miles along the river, near New Orleans, to prevent inundations; and notwithstanding, after the rainy season, the country is flooded from thirty to one hundred miles in width, and about four hundred miles from its mouth.

"The islands with which the river is strewed, are not like the graceful islets of the Loire or Seine, where, on a sward of rich grass, surrounded by a circle of osiers and willows, you see rising up, here and there, trees of all sizes, all ages, and every degree of foliage; no, but imagine banks of sand, or mud, in which grow to an equal size, and pressed together as far as the water's edge, trees which are often all of the same species and age, and can accurately indicate to the botanist, the year in which the river accumulated the deposit. Some of the banks are mere strands, on which no verdure is yet to be seen; these are the alluvium of the last spring. Others are covered with a delicate layer of suckers, which, at a distance, one might take for green turf, but which, on nearer approach, is discovered to be the leaf of the aspen or plane-tree. Elsewhere, the shrubs have attained the height of a man; they are pressed together like stalks of young chestnut trees, newly cut, and made into bundles."

"Finally, upon other islands, the trees have grown; the strongest have choked the weakest; those which remain have all the same vigour, the same height, and the same tinge. Various lianas, vines, smilax, bignonias, render it impossible to pass through them."* Such is a description of the Mississippi, and may apply, in a greater or less degree, to other rivers with channels already formed to carry off their waters. But what description will convey an adequate idea of the surface of the earth, during the first ages of the world, when cataracts, by the overflowing of lakes, and frightful inundations, by the bursting of their barriers, united with the mountain-torrent, to desolate the surface of the earth to an extent not easily estimated at present! The lakes of Canada are, doubtless, the remnants of those that existed in British America, before the bed of the St. Lawrence was formed; and the low lands of Europe bear evident testimony to the state of the country, before the channels of the Rhine, Danube, Don, &c., bore the accumulated waters to the sea.

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* Annals of the Faith, vol. vii, p. 395.

But, notwithstanding the extraordinary changes effected by rivers, it is not necessary to suppose that, in all cases, they have formed the valleys through which they flow. No; the natural features of the country determined the course of the river and the extent of its basin; though, in many instances, the valleys have been considerably increased or otherwise altered by them. We are told that forty square miles of land were in a few years* carried away by the Ganges; and we might recount many effects far greater than this, produced by the rivers of the Old and New Worlds. It would, however, be absurd to imagine that the basins of great rivers, or the valleys through which they flow, were exclusively the work of water, in immense periods of time. Water seeking its level, flowed to valleys, formed lakes, overflowed barriers, wore down strata, and, finally, furrowed its own bed. These effects, combined with those produced by inundations of the sea, hurricanes, earthquakes, volcanoes, &c., are sufficient to account for all the phenomena of geological formations.

If we go back in imagination to the early ages of the world, we will find vast portions of the earth inhabited by inferior animals, and man's influence little felt. Large tracts of country were covered with alluvial matter while submerged beneath the vast lakes which existed at that period. Several species of vegetables, buried deep under the deposits then made, became extinct, and innumerable animals were swept from the face of the earth, many of which left no analogous species behind them. "The birds, reptiles, plants, and insects, found in the Galapagos Islands, are, with few exceptions, a species found no where else in the world;" and had these been destroyed, the creatures which at present inhabit them would become extinct. So it was formerly: localities were submerged, and the plants and animals being peculiar, the species became extinct, and having left no analogous species, modern geologists erroneously refer them to very remote epochs.

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* Trans. Asiatic Society, vol. viii, p. 14.

Some idea may be formed of the multitude of animals which formerly existed in countries not subject to man, from what we at present witness. "It is believed that there exist in the pampas of Buenos Ayres, twelve million cows and three million horses. In the llanos or plains, from Orinoco to Lake Maracaibo, 1,200,000 oxen, 180,000 horses, and 90,000 mules, wander at large. In parts of the valley of Mississippi, wild horses are immensely numerous. The animals introduced by man in America, as sheep, hogs, dogs, &c., have increased in an equally wonderful manner. In the Galapagos Islands, the number of lizards, tortoises, and snakes is so great, that it may be called a land of reptiles."

To show how species might have perished in past times, and how animal remains may exist where no human fossils were present, the condition of the earth, even now, affords abundant examples. "When the river Apure is swollen, thousands of the wild horses which graze in immense troops in the savannahs of America, perish before they have time to reach the rising ground of the llanos." The turbid waters of the Batavian river, in Java, in the earthquake of 1699, brought down to the sea-coast, great numbers of buffaloes, tigers, rhinoceroses, deer, apes, crocodiles, &c.; and in the same island, in the year 1821, the river Tjetandoy bore down hundreds of carcasses of rhinoceroses, buffaloes, &c. Lyell directs the attention of geologists to the fact, that "the peculiar habits and distribution of the saurians of the Ganges, expose them to become embedded in the horizontal strata of fine mud."* The fossil remains most common in strata, are those of creatures whose habits expose them to greater danger, or whose means of escape were fewer. What Lyell remarks of the saurians of the Ganges, is equally applicable to that class of creatures, in all other places. The fossils of birds are comparatively few, from the facilities they possess of escaping from danger to which other animals are exposed. The paucity of human fossils is owing to man's sense of danger, and to the numerous means of escape which Providence has placed at his disposal; while the carcasses of the beasts slaughtered by those tribes who live by the chase, have added to the fossil-remains of animals.

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* Geology, vol. i, p. 359. See also vol. iii, p. 253.

Some species, being more limited in number and geographical distribution than others, may more easily become extinct. Any considerable local change in the physical geography of a country or district, which may deprive carnivorous races of food, may cause the extinction of species. The bursting of an isthmus, whereby a peninsula may suddenly be changed into an island, may be followed by similar results, either to carnivorous or herbivorous species. Certain species of animals may flourish in a district, from which, on being expelled by man, or by other invading races, they may perish, as might have been the case with many of the Liberian extinct animals.

Ancient lakes, whether formed by the overflowing of great rivers, or by the damming-up of the beds of small ones, contained fishes and shells in countless numbers. Their banks and islets swarmed with aquatic fowls, and vast sedimentary deposits were made. These have been frequently converted into salt lakes by the sudden inundations of the sea, in which cases, all the fresh-water animals perished, and were succeeded by marine. Great floods have often restored the preponderance of fresh water, and the marine animals, in their turn, fell victims to the change; and thus can we simply and naturally account for alternate fresh-water and marine deposits, which some localities exhibit. The change of fresh-water lakes into salt ones, occurred, universally, at the period of the deluge, when a great many species of animals became extinct.

Many of the marine lakes then formed, continued to exist for many years. Some were suddenly, and others more gradually, restored to their former state, and in both cases the marine animals perished. At the mouths of great rivers, as the Nile, Ganges, Mississippi, Rhine, &c.,

there exist lagoons, which are alternately occupied by fresh and salt water; consequently, fresh-water and marine strata must alternate in such localities, and fossils of each may exist in such places. Lym-Fiord, in Jutland, has been four times fresh, and as often salt, within the last thousand years. The last *eruption* of salt water occurred in 1824, when the North Sea entered, and killed all the fresh-water fishes, shells, plants, &c.

"The tribe of land-quadrupeds in the gypsum," says Lyell, "is such as now inhabit alluvial plains and marshes, the banks of rivers and lakes; a class most exposed to suffer by river-inundations."* Dr. Buckland affirms that "the deluge was followed by the sudden disappearance of a large number of *species* of terrestrial quadrupeds, which had inhabited these regions in the period immediately preceding it."† As these are the animals whose numerical preponderance among the earliest fossil-mammalia, beyond the proportion they bear among existing quadrupeds, is a remarkable fact, much insisted on by Cuvier, we are justified, on geological grounds, in supposing that many species, and perhaps families or orders, perished in the deluge.

The numerous species of animals at first created, multiplied exceedingly, and occupied the greater portion of the habitable globe. As the territories of man were extended, those of the animal creation were necessarily contracted, and this should tend to diminish their numbers, and, perhaps, cause the extinction of whole families. The dodo has become extinct within the historic period. So has the Irish elk; and the wolf, in our islands, is no more. Bears and lions were once numerous in Palestine;‡ the rhinoceros and hyena, in France; wild bulls, bears, and a peculiar species of deer, in Germany; the mammoth, rhinoceros, and hippopotamus, in Italy;§ and why not add, the mammoth, in Siberia, and the mastodon and megatherium, in America?

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* Lyell's Geology, vol. iv, p. 193.

† Buckland's Geology, vol. i, p. 94.

‡ 1 Kings, xvii, 37. 4 Kings, ii, 24.

§ See chapter xviii, p. 212.

"And of every living creature of all flesh, thou shalt bring two of a *sort* into the ark, that they may live with thee; of the male sex, and of the female. Of fowls, according to their *kind*, and of beasts, in their *kind*, and of every thing that creepeth on the earth, according to its *kind*; two of every *sort* shall go in with thee, that they may live."* In what sense are we to understand this passage? Shall the words *sort* and *kind* be interpreted by *variety*, *species*, *genus*, *family*, or *order?* *Species* or *genus* would seem to be the most probable. *Variety* would be too extensive; *family* or *order*, too limited. If these words mean *species*, then all the varieties of the different species of animals were left to perish. If by *genus* we are to explain the terms *sort*, *kind*, then all the *species* and all the *varieties* of the then-existing races of animals, were swept away by the deluge. Considering the dimensions of the ark, and the portion of it necessary to contain food for all its inhabitants for twelve months, it would appear that *sort*, *kind*, would mean *genus*. But, perhaps, the best interpretation will be, to suppose that pairs of each *genus* of wild animals, and pairs of each *species* of domestic animals, were preserved in the ark; or that pairs of each *genus* of unclean, and pairs of each species of all other creatures, were saved.

Admitting this interpretation, which seems so natural, we can easily account for extinct races; fossils of the wolf, fox, racoon, genette, squirrel, pelican, tortoise, crocodile, &c., have been found, *all of extinct species of existing families*, a proof that whole species perished, and that pairs were only saved, at least of some genera. The fossils of the extinct *pachydermata* animals have living types in the rhinoceros, hog, tapir, horse, &c., and the *mastodon* and *mammoth* may be referred to the elephant or hippopotamus, as the great *megatherium* may be to the sloth. Thus, all the extinct *species* can be referred to existing *families*, showing that whole genera disappeared at the period of the deluge, and that the facts which geology discloses, are in strict accordance with the narrative of Moses.

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* Gen. vi, 19, 20.

But, as regards amphibious animals, such as the seal, cayman or crocodile, hippopotamus, &c., are they to be numbered with the tenants of Noah? Probably, many species of this class were not in the ark; and in that case, what multitudes must have perished in the deluge, although some may have escaped! The common whale is of the warm-blooded mammalia, and breathes the atmosphere, though certainly not an inhabitant of the ark; neither was the lamantin, a species of the *cetacea herbivora*, which leaves the water to feed on the herbs growing upon land. The seal also, and probably a great many other species of this class, were not included in the ark, and accordingly, we may refer to this event the fossil-remains of the mammalia of this order, which Cuvier discovered in what is called the first eocene fresh-water formation. It is not, therefore, necessary to refer the extinct races to remote creations, or to epochs long anterior to the creation of man, as no discoveries in geology absolutely require such suppositions. The following circumstances will further confirm this truth.

The great quantity of organic remains pervading the strata of the earth's crust, has furnished data upon which geologists base their arguments in favour of distinct creations and remote epochs. "We find," says Dr. Buckland, "certain families of organic remains pervading strata of every age, under nearly the same generic forms which they present among existing organization. Other families, both of animals and vegetables, are limited to particular formations, there being certain points where entire groups ceased to exist, and were replaced by others of a different character."* "Another proof," he says, "of the length of time that must have elapsed during the deposition of those tertiary fresh-water formations in Auvergne, is afforded near Clermont, by the occurrence of beds of limestone several feet in thickness, and which is almost wholly made up of the *indusiæ* or caddis-like coverings, resembling the cases that enclose the larvæ of our common may-fly."* A large proportion of the entire substance of many strata is composed of myriads of those shells, reduced to a comminuted state by the long-continued movements of water. In other strata, the presence of countless multitudes of unbroken corallines and of fragile shells, having their most delicate spines still attached and undisturbed, shows that the animals which formed them, lived and died on or near the spot where these remains were found. Strata thus loaded with the exuviæ of innumerable generations of organic beings, afford strong proof of the lapse of long periods of time, wherein the animals from which they have been derived, lived, multiplied, and died." "Many extensive plains and massive mountains form, as it were, the great charnel-house of preceding generations, in which the petrified remains of extinct races of animals and vegetables are piled into stupendous monuments of the operations of life and death, *during almost immeasurable periods of past time*."†

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* Geology, vol. i, p. 110.

These are not exclusively the sentiments of Dr. Buckland, they are adopted by nearly all modern geologists. "Each of these strata, (and they are thousands of yards in thickness)," says a writer in the Dublin Review, "is the result of slow and gradual deposition, for the shells that are found therein would seem to have been formed in the very spot in which they are discovered."‡ From these facts, he admits the great antiquity, not alone of the earth, but of the races which inhabited it previously to the creation of man. The following facts, however, from the identical chapter of Buckland's Geology whence the above extracts are taken, afford ample data for deducing results directly opposite to those which geologists hold with regard to the formation of strata, and the antiquity of organic species.

"It remains," he says, "to state, that other causes seem to have operated occasionally, and at distinct intervals, to produce a rapid accumulation of certain strata, accompanied by the sudden destruction, not only of testacea, but also of the higher classes of the then-existing inhabitants of the seas. We have analogous instances of sudden destruction operating locally at the present time, in the case of fishes that perish from an excessive admixture of mud with the water of the sea, during extraordinary tempests, and also from the sudden imparting of heat and noxious gases to water, in immediate contact with the side of submarine volcanoes. A sudden irruption of salt water into lakes or estuaries, previously occupied by fresh water; or the sudden occupation of a portion of the sea by an immense body of fresh water, from a bursting lake, or an unusual land-flood, is often fatal to large numbers of the inhabitants of the waters thus respectively interchanged. The greater number of fossil-fishes present no appearance of having perished by mechanical violence; they seem rather to have been destroyed by some noxious qualities imparted to the waters in which they moved; either by sudden change of temperature, or an admixture of carbonic acid, or sulphurated hydrogen gas; or of bituminous or earthy matter, in the form of mud. The circumstances under which the fossil-fishes are found at Molte Bolca, seem to indicate that they perished suddenly on arriving at a part of the then-existing sea, which was rendered noxious by the volcanic agency, of which the adjacent basaltic rocks afforded abundant evidence. The skeletons of these fishes lie parallel to the laminæ of the strata of calcareous slate; they are always entire, and so closely packed together, that many individuals are often contained in a single block. The thousands of specimens which are dispersed over the cabinets of Europe, have nearly all been taken from one quarry. All these fishes must have died suddenly on the fatal spot, and been speedily buried in the calcareous sediment then in the course of deposition. From the fact, that certain individuals have even preserved traces of colour upon their skin, we are certain that they were entombed before decomposition of their soft parts had taken place. The fishes of Terra d'Orlando, in the bay of Naples, near Castelamare, seem also to have perished suddenly. M. Agassiz finds that the countless individuals which occur there in Jurassic limestone, all belong to a single species of the genus tetragonolepis. An entire shoal seems to have been destroyed at once, at a place where the waters were either contaminated with some noxious impregnation, or overcharged with heat. In the same manner, we may imagine deposits from muddy water, mixed, perhaps, with noxious gases, to have formed, by their sediments, a succession of thick beds of marl and clay, such as those of the *lias* formation; and, at the same time, to have destroyed, not only the testacea and lower orders of animals inhabiting the bottom, but also, the higher orders of marine creatures, within the regions thus invaded. Evidence that vast numbers of fishes and saurians met with sudden death, and immediate burial, is also afforded by the state of entire preservation in which the bodies of hundreds of them are found in the *lias*."

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* Geology, vol. i, p. 119.

† Ibid. p. 116.

‡ Scriptural Difficulties of Geology.

"It sometimes happens that scarcely a single bone or scale has been removed from its place; this condition could not possibly have been retained, had the uncovered bodies of these animals been left, even for a few hours, exposed to putrefaction, and to the attacks of fishes, and other smaller animals at the bottom of the sea. Another celebrated deposit of fossil-fishes is that of the cupriferous slate surrounding the Hartz. Many fossils in this slate at Mansfeldt, Eisleben, &c., have a distorted attitude, which has often been assigned to writhing in the agonies of death. The true origin of this condition is, the unequal contraction of the muscular fibres, which causes fish and other animals to become stiff, during a short interval between death, and the flaccid state preceding decomposition. As these fossil-fishes maintain the attitude of the rigid state, immediately succeeding death, it follows that they were buried before putrefaction had commenced, and apparently in the same bituminous mud, the influx of which had caused their destruction. The dissemination of copper and bitumen through the slate, that contains so many perfect fishes around the Hartz, seems to offer two other causes, either of which may have produced their sudden death."*

We have given this very long extract entire, to show other causes besides those already mentioned for the destruction of certain species of animals, as well as to point out the discrepant doctrines which geologists so often defend. We are told of strata, pervaded with animal remains, requiring tens of thousands of years for their completement; and again, of other strata of equal thickness, and similarly charged with fossil-remains, being almost instantaneously formed. Can anything be more erroneous than to conclude, from the mere *appearances* of fossil-fishes, that one set of strata required a million of years to form it, while another "was hardened to stone, in which myriads of fishes are interred, closely packed upon each other, and petrified ere decomposition could commence"? "A distorted attitude," assigned to "writhing in the agonies of death," is a notion scarce worth refutation. Fishes now, in whatever way taken, exhibit, after death, no such marks. If it be supposed possible for fishes, in their first effort to escape from a shower of volcanic ashes, which may overwhelm them, and which may suddenly become hardened in contact with water, to exhibit such signs as are noticed by Dr. Buckland, why will not fishes, destroyed by heat, or by noxious vapours, which must also writhe in the agonies of death, exhibit marks of such contortions? Why a few moments could suffice to convert a mass into solid stone, capable of supplying "thousands of specimens for the cabinets of Europe," and that millions of years should, in the other case, be required, will not be credited by any one who prefers rational conclusions, to vague speculations.

Rocks, "thousands of yards in thickness," might, perhaps, have been formed in deep valleys, by ancient marine or fresh water lakes; but to imagine such formations the result of deposits, slowly and gradually made, "in the lapse of countless ages," is not in accordance with those other geological theories, which allow no *fixed* continents, no *fixed* ocean-beds, no *fixed* races of organic beings, &c., and yet, when it seems to serve the purpose of geologists, a fixity of things is supposed to exist during those immeasurable periods of time, necessary for the deposition, by a still sea, of those beds of strata, thousands of yards in thickness! Either those vast deposits were made in much shorter time, or the continents are fixed upon unalterable bases, and the basins of the ocean have ever been unchanged.

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* Buckland's Geology, vol. i.

There is no sufficient reason to conclude, from organic remains, that any set of strata occupied extraordinary length of time in its formation; on the contrary, every circumstance indicates sudden consolidation. Where the bodies of fishes are preserved entire, it is certain the masses which contain them, were formed very rapidly. In fact, whatever be the condition of the fossil-remains, a slow rate of formation seems incompatible with the process of aqueous deposition. These depositions are of two kinds, mechanical and chemical: the former consists of the matter produced by running water, as mud, sand, pebbles, &c.; the latter consists of precipitates, as where carbonate of lime or silica is held in solution, until separated by chemical action. An excess of carbonic acid holds lime in solution: when part of this escapes from the water, the calcareous matter is thrown down in a solid state, and will then encrust wood, shells, stones, leaves, &c., or cement masses of sand, shells, &c. But this is rather sudden than gradual, though, of course, repetitions of the operation may be continuous. The masses thus bound together, may be marine or fresh water, or these may alternate; but nothing in these operations, argues indefinite periods of time.*

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* "An analysis lately made of the water which was flowing off from the mud deposited by the Hoogly river in the delta of the Ganges, after the annual inundation, was found to be highly charged with carbonic acid gas, holding lime in solution." Strata would be rapidly cemented by deposits from such water.

The presence of organic remains in strata may arise from other causes besides those we have been noticing. There are many facts to show that certain classes of creatures abide at various depths in the earth's crust, where they live, multiply, and deposit their remains.

Professor Jones informs us, that the ocean at first was inhabited by animals "in an infinitude of forms, many of soft parts, but at the same time also those shell-clad creatures, that had to leave their investments as monuments of their having existed; . . . . that the animalcula, which multiplied beyond conception, formed on the bottom of the ocean the *grass* upon which superior animals had to feed; that shell-fishes of the most beautiful kind were made to feed upon this living pasture, that nature so abundantly brought within their reach; and most of these shell-fish were rooted, by little pedicles, to the rock where they lived."*

This learned Professor testifies, that the bottom of the sea was literally covered with living creatures; and Professor Ansted says, that, "at moderate depths in the seas of the southern hemisphere, they found certain groups of animals existing, which were totally different from the animals near the surface in warm water."† These and similar facts lead us to infer that each stratum of water, from the bottom to the surface of the sea, is occupied by creatures whose constitutions are so adapted to the regions they inhabit, that a much greater or less depth of water would be as unsuited to their natures, as the deserts of Arabia would be to the rein-deer of Lapland, or the wilds of Siberia to the African camel.

On land, as well as in the ocean, different creatures inhabit different degrees of depth. Water pervades the earth's crust at all known depths, and, probably, far deeper than we imagine; and as animals can exist wherever air or water can be present, animal life may be expected in all conceivable situations within the earth's crust. Vegetables, also, grow in the most secluded places; the deepest seas, and the most obscure caverns, have their peculiar classes, and hence, organic remains may exist wherever air or water can penetrate.

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* Lectures in Manchester.

† Lectures in Cork.

" Mud called *moya*, from the sides of Tunguragua, in 1797, filled valleys a thousand feet wide, to the depth of six hundred feet, forming barriers by which rivers were dammed up, and lakes formed. In these currents and lakes of moyd, thousands of small fish are sometimes enveloped, which, according to Humboldt, have lived and multiplied in subterranean cavities. And so great was the quantity of these fishes ejected from this mountain, at one period, that fever, which then prevailed, was attributed to the effluvia arising from their putrid bodies."

" At Riemke, in Westphalia, the waters of an artesian well brought up, from a depth of one hundred and fifty-four feet, several small fishes, three or four inches long, though the nearest stream in the country was at the distance of some leagues."

Living shell-fish were found at great depths, in gravel-beds, in digging the Eire canal.

" At Tours, in 1830, a well was perforated quite through chalk, when the water suddenly brought up, from a depth of three hundred and sixty-four feet, a great quantity of fine sand, with much vegetable matter, and shells. Branches of thorn, several inches long, much blackened by their stay in the water, were recognised, as also, stems of marsh-plants, and some roots which were still white, together with seeds of the same in a state of preservation, which showed that they had not remained more than three or four months in water. Among the shells were a fresh-water species, and some land species."

These facts, for which Lyell is our voucher, demonstrate that organic remains may exist beneath extensive strata of chalk or other matter, without having been deposited in such places before the formation of the incumbent strata. It will not, therefore, follow that strata containing organic fossils, and deep in the earth's crust, were deposits anterior to those which rest upon them; nor can any proof of the earth's great antiquity be deduced from such data. Various strata of water, each containing its own peculiar animals, permeate the crust of the earth; and wherever this can accumulate, in caves or in the fissures of strata, greater or less lakes will be formed; animals will multiply and perish; plants will grow, and organic remains will be present, where few could imagine those plants and animals capable of existing.

Neither will it follow, that solid rocks of limestone or any other species, which may contain fossils, had once been in a fluid state, or a deposit from water. Many such rocks, we admit, were mechanical formations, but many exceptions could exist to the general rule.

"The burrowing shell," says Professor Jones, "which had to make its way into the mud, or into the stone, was covered over with a very delicate kind of file. Whether this had the power of corroding the rock or not, it was difficult to say, without some other operation, because this file was as delicate in structure as could be; and, being made of carbonate of lime, like the rock itself, it might be thought that the shells would be worn away, before the rock would be filed into holes. Nevertheless, they did, by some mysterious process, work a way into the interior of rocks, and when the shells had got there, they enlarged the hole, that, hermitlike, they had constructed for themselves. When they first entered the rock, they were of very small size, and while there, they were constantly growing."

Lyell says, "The lithodomi are molluscous animals, that form holes in solid rocks, in which they lodge themselves. The holes are not perforated mechanically, but the rock appears to be dissolved." Mr. Babbage discovered in the coast of Puzzuolo, along the face of a perpendicular rock, consisting of very hard tufa, that the rock was drilled by boring testacea; some of the hollows of the lithodomi contained the shells, whilst others were filled with the valves of a species of *arca*. The holes of these creatures are pear-shaped, the external opening being minute, and gradually increasing downwards. At the bottom of the cavities many shells are still found."

"Burrowing shells can sink when alarmed, with considerable rapidity, in mud several feet, and can rise again even if a mass of matter is heaped upon them." With this power of penetrating solid rock, and sinking rapidly in mud, and rising again through heaps of superimposed matter, the presence of the burrowing shell in any kind of strata should cause no surprise. Nor is this power of penetrating matter confined to lithodomi; other creatures possess it too, in various degrees, and consequently, no argument which can be deemed conclusive, in favour of the great antiquity of extinct animals, or the strata which contain them, can be drawn from organic-remains.

Lizards and serpents lie in a state of torpor, in the fissures which are made during the dry season, in the llanos of the Orinoco. Earth-worms live near the surface, in almost all kinds of soil, and they are found different, as the soils and climates vary. Living fishes and shell-fish are found, at various depths, remote from lakes, rivers, &c. The fishes and insects of the Kentucky caverns, which seem not to possess the organs of sight, appear to have been created for the locality they inhabit. These and similar facts justify the supposition, that animal life pervades the earth's crust, or great portions thereof, and in some cases, even to great depths; and that these are distributed in localities suited to their nature. As the different strata of water in the ocean, and the different climates of the earth have their appropriate tenants, so a similar law of distribution extends to creatures within the earth's crust. "There seems to be no condition," says Professor Ansted, "either on the earth, in the water, or in the air, which is not favourable to the existence of life in some form, and that was not life for a moment, but prolonged and protracted." We find every situation where air or water can penetrate, occupied by organic beings, and created, as it were, to exist under every conceivable circumstance.

Water, or any other substance capable of sustaining animal life, placed in the most secluded places, and remote from every communication with other bodies, save the air which surrounds it, will soon teem with life. And unless we admit with regard to animals, what is undeniable as regards vegetable seeds, namely, that the atmosphere abounds with countless millions of invisible creatures, which are borne by the winds to all possible places, where, under favourable circumstances, they live and multiply; it will, in several cases, be difficult to account for the presence of animalcula.

No plant or animal comes into existence without parentage. Vegetable seeds, when excluded from air and moisture, retain the vegetative power for a very long time. And with respect to marine vegetation, the seeds being in their native element, may remain immersed in water without injury, for indefinite periods. The floating sea-weed is a striking instance.

The lowest orders of vegetables are those of the *cryptogamia* family. The *fungi*, *mosses*, *lichens*, *sea-weeds*, &c., are of this race. "The fungi are the lowest in the scale, and appear in various forms; as puff-balls, mushrooms, mildew, mould, &c. This last is the lowest of the group, and makes its appearance on the surface of various familiar objects; as decaying paste, cheese, old shoes, &c. It is always a harbinger of decay, and exhibits the first appearance of decomposition. How vegetation should appear in so secluded a situation as the inner cracks in cheese, or in a jar of preserves, placed carefully in a cupboard, or on the leather of an old boot, in the remote corner of a bed-closet, is at first sight incomprehensible; but a consideration of the reproductive powers of fungi at once explains the circumstance. The whole fungous tribe possess the most extraordinary powers of production. Instead of propagating by the ordinary and slow process of elaborating and throwing off seeds, they increase by the dispersal of their entire substance. Every particle in their mass is a germ, which, though smaller in bulk than a particle of fine dust, and generally so minute as to be invisible to the naked eye, is the embryo of a new plant, and will develop its powers of vegetation, as soon as placed in an appropriate situation for its growth. In this manner a *toad-stool*, having performed its office, and exhausted its means of nourishment, shrinks, dies, and dissolves in millions of atoms, which, being liberated and floated away in the atmosphere, are deposited in every imaginable situation. Some are inhaled into the lungs of animals, whilst others enter into the fabric of trees, herbs, and, in short, they find admission into every exposed and penetrable substance."

The *algæ,* or sea-weed, embrace a still more minute form of vegetation. The *red-snow* or *bloody-rain,* which is no rare phenomenon in the north of Europe, is one of these forms. The tinging matter, when examined by the microscope, is found to proceed from vegetables or animalcula, both too small to be seen with the naked eye.

The singular properties of these plants, and the secluded situations in which lichens, mosses, and the other tribes of humbler vegetables flourish, show that there is no cleft or crevice in which air or water can enter, which may not produce some species of vegetable. "Fungi," says Fries, "are so infinite, that in a single individual I have counted above ten millions, and so light, that they may be raised by evaporation, and be dispersed by the attraction of the sun, by insects, winds, elasticity, adhesion, &c., that it is difficult to conceive a place from which they may be excluded." "The germs of fungi, mosses, lichens," says Lyell, "consist of an impalpable powder, and go to all places."

The atmosphere abounds with animalcula, as well as with invisible seeds. We can scarcely conceive any object so small as may not contain some of those minute creatures. Seeds, sands, dust, &c., borne by the winds, carry with them their animalcula; and what some naturalists attribute to new creatures, are, in reality, produced in this manner. "Strong gales of wind sweep along at the rate of forty or fifty miles an hour. Whirlwinds and hurricanes root up trees, throw down buildings, carry off heavy fruits and seeds, dry up lakes and ponds, and carry insects, land-testacea, and their eggs, with many other species of animals, to points they could not otherwise have reached, and from which they may propagate themselves again as from a new centre. Birds of passage carry seeds, eggs of fish, insects, mollusca, and other creatures to distant regions."*

With animal and vegetable life in such profusion, and with such powers of multiplying, that one plant may produce millions of others, and the largest amount of putrid or putrefying matter in a few days, under favourable circumstances, may become one mass of living beings; we should rather be surprised at the admirable system of nature, which by checks and counter-checks restrains life within due limits, than at the secluded situations in which organic remains are found. The waters of the ocean penetrate the earth, and fill cavities in its bowels with salt water containing marine animals; should the communication with the sea be cut off, and fresh-water descend to these caverns from the surface of the earth, all those appearances sometimes exhibited by alternate layers of marine and lacustine deposits, would be found. Lake Laguna, in Haiti, is fifty miles in circumference, and twenty miles from the sea, is as salt as the ocean, and has the same flux and reflux as the tide, and abounds with sharks, seals, porpoises, and other marine animals. Were the communication with the sea cut off, and the lake dried up, and the strata of the bottom examined, geologists unacquainted with the ancient lake, would unhesitatingly affirm, that the ocean once flowed over this locality, or that Haiti was submerged at some former period.

The tendency to vegetate is a perpetual and restless power in nature.† The rocky beds of the deepest seas are covered with immense fields of sea-weed. The ocean teems with life, and the dark recesses of the earth's crust have their animal and vegetable occupants; and it is a fact deserving especial notice, that the fossils of the earlier, or lower strata, are of these humble orders of plants and animals, the identical classes, which, in the natural order of things, should be found in those strata, and which should be the victims of those changes to which the earth is subject.

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* Lyell's Geology, vol. iii, p. 33.

† Numbers of seeds are furnished with downy and feathery appendages, enabling them when ripe to float in the air, and be wafted by the most gentle breeze. Other plants are fitted for dispersion by means of an attached wing, as in the case of the fir-tree-seed, &c.

As delicate shell-fish can work their way into solid stone, and organic beings exist where air or water is present; as the lower orders of creatures are the forms discovered in tertiary and secondary strata; and as the fossils of larger animals belong to species whose habits expose them to destruction by floods, and other accidents, there are natural causes enough to account for the presence of organic remains in rocks, without having recourse to any other causes, save those of daily occurrence. The rapidity with which plants and animals multiply; the migratory propensities of many species; the *range* of climate which plants and animals are naturally enabled to endure, make it quite unnecessary to introduce new forms of life to meet those physical changes which must occur on earth. No changes can occur in the physical world, to which the nature and habits of some existing races are not adapted. In the beginning, the number of species was greater than at present, and the well-being of all required, that it should be so; now, man greatly modifies the distribution of organic beings. "He drives away the animals that are dangerous or injurious to him, and collects around him such as can be useful. By his agricultural operations he removes the aliments of some, while he provides that of others. He extirpates some plants, and cultivates others. He appropriates the soil in which some plants would prosper, to those which may serve him for food; and thus many species have become extinct, or are no longer found in countries to which they were formerly indigenous."

In every point of view in which this subject is considered, no facts of natural history, physical geography, or, even, of geology, require anything contrary to the obvious meaning of Scripture. Adequate causes exist for all the phenomena we behold, without vague theories of rock-formation, geological epochs of immeasurable length, or distinct and successive creations of organic beings.

CHAPTER XX.

Remote eras—Indefinite periods, &c.—Extended signification of the term 'day'—Days of creation and Sabbath day contrasted—Sabbath day, no indefinite period—Simultaneous creation of heaven and earth—Condition of the earth previous to the fourth day—Opinions of Origen and St. Gregory Nazianzen—Existence of the sun from the beginning, compatible with the Scripture narrative—Opinions of the Holy Fathers—Holy Fathers wrote as if the days were natural days—Indefinite length of the days of creation, incompatible with facts—Mosaic narrative more scientific than geological theories—Economy of nature deranged by the indefinite length of the third and fourth days—Atmosphere, mountains, magnitude, &c., of the sun—Earth and sun contrasted—Difficulties involved in geological theories—Literal meaning of Scripture—Moon and planets—Light of the first day—Effects of the sun's rays—Geological dilemma—Opinions of Lyell—Opinions of those anxious to reconcile Scripture and geology—Concessions—Conclusion.

If there have been no successive creations of organic beings, as the facts detailed in the foregoing chapters lead us to believe, then, the theories of *indefinite periods, remote eras*, &c., are no longer tenable, as the arguments which disprove the former, apply to the latter. Were the days of creation indefinite portions of time, amounting to myriads or millions of years, geologists would have some reason to suppose that distinct races of organic beings existed in by-gone ages. But were they only ordinary days of twenty-four hours, the theory of successive creations would have neither fact nor argument to support it.

We do not mean to affirm, that using the term *day* in a more extended signification than that word usually conveys, would be contrary to Scripture. But in reference to the days of creation, its meaning seems limited to a natural day, and has been so understood in all ages.[*] No distinction is made between the days of creation and the Sabbath day; and as the latter is evidently to be understood as a common day, each of the other six days should be viewed in the same light, and not as unlimited periods. "Six days shalt thou labour and do all thy works, but on the seventh day is the Sabbath of the Lord thy God. . . . .For in six days the Lord made heaven and earth, and the sea, and all things that are in them, and rested on the seventh day: therefore the Lord blessed the seventh day, and sanctified it."*

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[*] See Josephus' Antiquities of the Jews, book i, chap. 1.

Were each one of the six days to consist of thousands or tens of thousands of years, and the Sabbath day but of twenty-four hours, the analogy could not hold good. Many, however, try to make the case analogous, by making the Sabbath day also a figurative day, by interpreting it as the eternal rest of the Creator, and by supposing it to have commenced at the termination of the six days' work, and still to continue. But no sophistry can justify such an interpretation. The faithful of all ages, under both the natural and the written law, as well as under the law of grace, by the actual observance of one natural day in the week as the Sabbath, with one voice proclaim that no such figurative signification was either meant by the law-giver, or understood by the people. If, then, the Sabbath day must be considered as a natural day of twenty-four hours, the other six days of creation must be considered so too.

If geologists adopt the figurative Sabbath, they cannot reconcile that interpretation with the theory of *successive creations of organic beings,* consistently with the Scripture narrative. For if God blessed the seventh day and sanctified it, because in it he had rested from all his works; and if by the seventh day is to be understood the eternal rest of the Creator, then the theory of successive creations and this interpretation would be directly opposed to each other. In such case the constant creation of new orders of creatures, distinct from any that preceded them, would in no manner differ from the work of the six days, and God could *not* be said to have rested from his work at the end of the sixth day. Now, if God rested at the end of the sixth day, that is, ceased from producing any new kind of work, whence could come those new races, which geologists say are constantly being created? Either the days of creation, like the Sabbath day, were days of ordinary length, or geological theories, in reference to Scripture, are hostile to each other. Taking the Sabbath as an ordinary day, geologists might say with some show of reason, that after His temporary rest, the Creator commenced anew to produce new orders of creatures; but by supposing it to be of unlimited duration, to be, in fact, the eternal rest of the Creator, they cannot, consistently with the Scripture narrative, affirm that new orders of creatures are continually being produced; for how, in that case, could He be said to have rested from His labours? Either, then, the doctrine of successive creations must be given up, or the Sabbath day must be admitted to have been an ordinary day, and, consequently, all the other days to have been but of ordinary duration. Geologists, in attempting to reconcile some of their doctrines with Scripture, thus involve other theories in difficulties, which cannot be reconciled even with their own hypotheses.

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* Exodus, xx, 9, 10, 11.

Scripture and science concur to demonstrate the simultaneous creation of heaven and earth. "In the beginning, God created heaven and earth."* "He that liveth for ever created all things together."† Hence, the sun, moon, and all the other heavenly bodies, are coeval with the earth. This the word of God declares; this the truths of science confirm. Had the earth existed previously to the sun, it could not, according to the laws of motion, possibly move in its present orbit; and there could be no object in giving it a motion on its axis. It would, therefore, have been quiescent during the first, second, and third days, and its annual and diurnal motions could not commence until the fourth. This state of things would coincide with the notions of those who deem a gradual advancement to perfection, a necessary principle in the works of nature; but he who contemplates the infinite power and wisdom of the Creator, can recognise no "abortive efforts to produce perfect beings," or perfect systems. The Almighty produced the material world all at once, by one act of divine power; but for his own wise reasons, and for man's instruction, He unfolded and arranged it in the subsequent work of the six days' creation.

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* Genesis, i, 1.

† Ecclus. xviii, 1.

"Who that has sense," exclaims Origen, "can think that the first, second, and third days were without sun, moon, or stars?" and St. Gregory Nazianzen, "For the voice of the Lord is the voice of power, at the command of which, in the beginning, light, *and every created thing,* sprang into existence." Our planet would exist very anomalously without a sun or moon, and hence, the co-existence of these, from the beginning, is declared by Scripture, affirmed by the Holy Fathers, and demonstrated by those branches of science which refer to astronomy and the laws of motion.

Why, then, is it expressly said that the sun, moon, and stars were created on the fourth day? The Holy Fathers account for this, and for the creation of light, "by supposing this luminary to have indeed existed, yet, so as that its rays were prevented, by the dense chaotic atmosphere, from penetrating to the earth; this was on the first day so rarefied, as to allow the transmission of the sun's rays, though not the discernment of its disc, which was fully displayed on the fourth day."* St. Cyril of Alexandria supposed the light of the first three days of creation to have been "the element of fire, which, shooting up towards heaven like a luminous globe, shed its rays upon the earth." St. Augustine considers it "as a spiritual illumination from heavenly intelligences." St. Denis maintains that "it was the sun itself, which had not yet arrived at the perfection of its height." Others thought it was "the transparency of the empyreal heaven;" while others again supposed it "a certain shining material or luminous substance, from which the sun was formed upon the fourth day." St. Thomas calls this light, "the beginning of the sun."

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* Cardinal Wiseman's Lectures on Science and Revealed Religion, vol. i, p. 298.

These different interpretations are the best proof of the difficulty of this subject; but were the architecture of the heavens understood as well then as it is now, we have little doubt, but that the sentiments of Origen and St. Denis would have more advocates. At that time the Ptolemaic system of astronomy prevailed; the earth was supposed to be fixed, and in the centre of the system, and was looked upon as the first and most important of the planets. The sun, moon, and stars were deemed of secondary importance, and might, hence, be supposed as subsequently formed. The *successive* work of the six days' creation accorded with the astronomical ideas of the Holy Fathers; and, consequently, the existence of the earth, without a sun or moon, presented no scientific difficulties to those early writers, otherwise they never would have supposed that the sun and earth were not coeval. But looking on the earth in its chaotic state, immoveably fixed as the centre of the subsequent creation, and connecting this idea with the work of the first and fourth days, the opinions of the Holy Fathers will appear to be more rational than when considered in reference to the system of Copernicus.

The creation of a firmament, the division of the waters that were under it, from those that were above it, the gathering of the waters into one place, the appearance of dry land, the bringing forth of the green herb and the fruit-tree, and the works of the fifth and sixth days, afforded the Holy Fathers just reason to suppose that a similar progressive manifestation of the divine power took place in the formation of the heavenly bodies. They might believe that the earth, as the first and principal one, was created in the beginning, and fixed in the centre; that the embryo, or "the beginning of the sun" was created on the first day, and perfected on the fourth; or, according to others, that "the elements of fire," or some other "material luminous substance," from which the sun was subsequently formed, was produced on the first day. These notions accorded well enough with the Ptolemaic system of astronomy, and the analogous progressive advancement displayed in the other works of creation. But when tested by modern science, and contrasted with the theories of the day, the opinions only of such of the Fathers as admitted the existence of the sun from the beginning, can be deemed unobjectionable.

The formation of the sun from some pre-existing luminous material substance, savours too much of the modern nebular theory, to meet our approval; nor can we advocate any gradual advance to perfection in the production of this magnificent luminary. The existence of the sun on the first day is unquestionable, though its manifestation on earth was undoubtedly reserved to the fourth. This opinion is supported by Scripture and science. In the first chapter of Genesis, first verse, it is said that *heaven* was made in the beginning; and in the eighth verse of the same chapter, the firmament, which was made on the second day, is called heaven. Here we have a portion of what was created in the beginning, noticed again as a part of the second day's work. The heaven created at first, cannot be taken as distinct from the heaven of the second day, for both evidently refer to the expanse of the sky, and not to the heaven of the blessed. Neither can it be understood as a general notice of what was to follow, for no allusion is made in any of the subsequent verses, to the creation of the earth, which, with the heavens, are both expressly said to have been created together. This case is quite analogous to that of the sun; its actual existence on the first day is not incompatible with its further development on the fourth. As the heaven created on the second day is but a particular notice of that which was made in the beginning, so the sun and moon of the fourth day are but the manifestation of what had existed as long as the earth or heaven of the "*beginning*." All matter was created together, and the work of the six days was but the arrangement and ordering of that matter by infinite Power. Hence, the work of the fourth day must only mean the *first exertion of the sun's rays on the earth.* We do not say the first exertion of the sun's *influence* on the earth, for there can be no doubt, but the earth's annual and diurnal motions commenced with its creation, and hence, the sun's gravitating influence must have existed during the first three days.

This interpretation is in strict conformity with Scripture and science, and tends to demonstrate the days of creation to have been no other than ordinary days of twenty-four hours, and not indefinite periods of time. As such the Holy Fathers understood them, and in this sense only were their interpretations of the Scripture narrative given. Had they the slightest idea of the indefinite periods of time which modern geologists affix to them, they never would think that "the sun's rays could reach the earth, and his disc be indiscernible," during the indefinite lapse of ages, involved in the first three days of creation. The interpretation which the Holy Fathers gave was rational and intelligible in the light in which they viewed the subject; but no such explanations can be admissible when the days are considered as geological epochs or indefinite periods.

Were we to grant the existence of the sun for the first three days as indefinite periods of time, we should also grant its full influence upon the earth during those periods, or refuse to make any such concession. In the former case, the words of the inspired writer, which declare the sun to have been created on the fourth day, will be entitled to no credit, and the Scripture narrative a mere waste of words. In the latter case, it would be the height of absurdity to suppose the vegetable kingdom could subsist for such a length of time without the sun's light, heat, and all those other advantages which it derives from that luminary. In a mere philosophical point of view, then, the Mosaic narrative, in its plain and obvious meaning, is just, rational, and accords with the existing laws of nature; while the geological theory involves absurdities in a scientific point of view, and impieties in its religious tendency. It is absurd in supposing the first three days indefinitely long, and no sun to shed its blessings on the vegetable world; or if the sun's influence be supposed unimpeded during all this time, it is impious in making no account of the Scripture narrative, which expressly refers the creation of the sun to the fourth day, and, consequently, denies its influence on the earth for the first three days.

If, with the Holy Fathers, we deem the third day but an ordinary one of twenty-four hours, the absence of the sun for that short time could not affect the vegetable kingdom, and its appearance on the fourth day was precisely at the time when its presence was wanted. Animals appeared when the sun was ready to cheer and enliven them, and the vegetable kingdom prepared to supply them with food; and in every part of the six days' work we find the creation of something new, when the antecedent portion required its presence, or was fitted to supply its want.

> "Order is Heaven's first law."

Were the third and fourth days indefinitely long, the admirable economy of the visible world would have been totally deranged: vegetables would multiply, but there would have been no checks or counterchecks to retard the increase of any. Plants would have "no insects to curb their luxuriancy, and prevent them from multiplying to the exclusion of others."* Lakes and rivers would have been formed on the fourth day, and *vegetable deposits* made in places where no *animal remains* could be present in after ages; but such is not the fact, for all the fossils hitherto discovered, and all the strata which have been examined, directly prove the *coexistence* of animals and vegetables from the earliest ages. So that, in a scientific point of view, the literal meaning of the text is rational and consistent, and, moreover, it accords exactly with geological discoveries, while the figurative meaning is opposed to the laws of nature, at variance with the existing system of the world, and would lead to results directly contrary to those which the facts of geology indicate, in the coeval existence of plants and animals. Why, then, should the crude notions of rash and reckless theorists be adopted, and the meaning of the Scripture narrative rejected as a "vulgar error"?

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* See chap. xvii p. 197.

Had the first, second, and third days of creation been long geological eras, and had the influences of the sun and moon extended to the earth, as the vegetable world would require, and as modern theories demand, the inspired writer could have no object in stating, that the creation of those luminaries was reserved to the fourth day. If the earth had enjoyed the full benefit of the sun's rays during long periods, antecedent to the fourth day, the law-giver of Israel could have no object in delaying to notice it so long. And as no Christian will suppose that Moses wrote at random, or incoherently, no effect of the sun upon the earth, save its gravitating influence, which chaos itself could not impede, can be consistently admitted before the fourth day. Consequently, no formation of strata by lakes or rivers; no disintegration of rocks by the alternations of heat and cold, of freezing and thawing; no reconsolidation of others by those causes which the sun's influence on the earth is alone capable of producing, could have taken place previously to the fourth day; and hence, those geological theories, which make each day of creation consist of myriads or millions of years, are opposed to Scripture, to tradition, to science, and to common sense, and we may add, contrary to geological facts; for if, as Dr. Buckland remarks, no geological proof exists to show that vegetables were anterior to animals, how comes it that an immense lapse of time, a vast geological epoch, viz., the fourth day, intervened between the creation of plants and animals? Need stronger arguments be required to show the inconsistency of modern theories, than this glaring condemnation of geological speculations by geological facts?

In every point of view wherein this subject is considered, geological theories seem to have no one substantial fact or argument to support them. The Mosaic narrative, in its plain and obvious meaning, is more and more confirmed by arguments deduced from each new phase in which it is presented to our consideration. The diameter of the sun is upwards of 111 times that of the earth, and its magnitude

1,384,472 times that of our planet.* Mountains on the sun are estimated at 334 miles in height, and many even attain the elevation of 500 or 600 miles.† The least space which can be distinctly discerned on the sun as a *visible area* must be 465 miles in diameter, containing an area of 220,000 square miles; and spots have been observed whose lineal diameter has been upwards of 45,000 miles, and whose area, consequently, would be above seven times the surface of this globe. That such spots should close up in six weeks (for they hardly ever last longer), its borders must approach at the rate of more than 1000 miles per day. The atmosphere of the sun consists of various elastic fluids, that are more or less lucid and transparent, and of which the lucid one is that which furnishes us with light. The sun itself appears to be nothing else than a very eminent, large, and lucid planet, evidently the first in our system, as its solidity, its luminous atmosphere, its diversified surface, its rotation on its axis, &c., demonstrate. That its temperature is very elevated is not doubted, and that an intense heat prevails in its interior is highly probable, by which its elasticity is reinforced, and rendered capable of resisting the almost inconceivable pressure which would otherwise collapse it into smaller dimensions.‡

We make this allusion to the sun to show, that if the earth required myriads or millions of years to fuse its rocks, to constitute soils, to form its coal-beds, to make its chalk and limestone, to give existence to several successive races of organic beings, and to destroy them again; to pass through a series of convulsions, submersions, &c.; in a word, to be the theatre of numberless catastrophes, and all seemingly for one specific object; namely, to become a fit habitation for man, and those creatures formed for his use; how much more justly should longer periods be assigned for its own purposes to that immense globe, the sun! In comparison to it the earth is but a mere speck; it would, therefore, have required a longer time still, that its immense mountains might have been up-heaved; its solid mass confined within due limits by the equilibrium of its repulsive and attractive powers, the former arising from its intense heat, the latter from its great magnitude; its luminous and transparent atmosphere rendered fit for the emission of light; and its whole mass suited to the important part in our system which has been assigned it by the Creator!

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* See Herschel's Astronomy, pp. 192, 207.

† London Encyclopædia, vol. xxi, p. 404.

‡ Herschel's Astronomy.

It is not just, on the part of geologists, to allow millions of years to the earth, that it may become a fit abode for man, and at the same time to allow none to the sun, though acting a more important part in the system of which it is the centre and the soul. The theories of geologists assign the earth countless ages to arrive at its present state of perfection; but they require the attendance of the sun upon our planet from the beginning. The earth and its inhabitants they suppose to be gradually advancing to a more perfect state, but, forsooth, the sun must, *ab initio*, have been unalterably fixed in its present perfect condition. If the earth underwent a series of changes before the appearance of man, why not also suppose the sun to have been undergoing changes, and gradually attaining to higher and higher degrees of perfection from the "beginning" until the fourth day? Were we even to grant the days of creation as indefinite periods, we should, in justice, insist upon the sun's requiring the first three days to attain that perfection which it displayed upon the fourth. But even this concession would not suffice, as geological theories require the full exertion of the sun's influence upon the earth during all the days of creation, without any regard to that portion of Scripture which fixes the creation of the sun and moon upon the fourth day.

In fact, the Scripture narrative interferes directly with geological theories, and whatever be the attempts to reconcile them, no perfect union is likely to take place. Geologists may trace a parallelism between the gradual advance of fossils through the different strata, and the Scripture account of the creation. Theologians may make concessions perfectly consistent with the Catholic rule of Scripture interpretation, but as long as geological theories are framed without any reference to the distinctive marks of each day of creation; as long as they are contrary to true science, natural history, and the existing phenomena of nature; as long as they are opposed to each other, and subversive of known truths; as long as they are based upon mere possibilities, and fashioned to the whims of every speculative theorist, so long will Scripture and geology be totally irreconcilable.

The inconveniences resulting from considering the days of creation as indefinite portions of time, are altogether obviated by the literal interpretation. The earth, from its chaotic state, is suddenly divided into land and water; another act of Omnipotence instantaneously clothes it with all the freshness and verdure of spring, united with the bloom and beauty of summer, and the abundance and riches of autumn. Vegetables of every species, in their most perfect forms, are diffused over its surface, and suited to the various climates. The morning of the fourth day unfolds its treasures to the rising sun, and every subsequent portion of creation, as it emanated from the hands of God, displayed the perfections of Him who had given it existence.

Though the stars and planets, as well as the sun, had existed from the beginning, they were not revealed to the earth until the fourth day. The planets, which are only visible by the sun's light, could not be said to have been created sooner. To admit the existence of these heavenly bodies for the first three days, when taken as periods of twenty-four hours, is not opposed to Scripture; for in truth, as far as regarded the earth, which was the subject of the inspired writer's narrative, they were as if they were not, until their manifestation on the fourth day; but when those days are regarded as indefinite periods, the case is otherwise, for the subject then becomes involved in difficulties. The sun's influence cannot, consistently with Scripture, be supposed to have extended to the earth before the fourth day, nor the vegetable world, conformably to physical laws, exist until the fourth day without the sun's rays. In this dilemma, either the Scripture narrative, or the indefinite periods, must be sacrificed; and different parties will, of course, select their victim. Modern geological theories seem to regard very lightly the Scripture account of the creation; and there seems no reason, either from facts or science, why those who revere Scripture, should make concessions in favour of reckless theories. The Holy Fathers made none; for geological epochs, successive creations, and vague theories of rock-formation, were not among the errors of their days; all their comments upon the first chapter of Genesis were based upon the literal meaning of the text, which, in fact, is the only meaning which involves no absurdities, no physical difficulties, no subversion of the laws of nature.

St. Basil, St. Gregory Nazianzen, Theodoret, and other ancient Fathers, imagined the *light* which was created on the first day to have been an accident, without a subject, unattached to the sun until the fourth day. Were this so, and the case is neither impossible nor unphilosophical, much of the difficulty attending this subject would be removed, as the existence of light would be accounted for without prejudice to Scripture or science. The body of the sun might have occupied its place in the centre as at present, and extended its gravitating influence to the surrounding planets; the motions of the earth and of the heavenly bodies may proceed in their ordinary courses till the fourth day, when the union of light with the pre-existing mass of the sun, would display this luminary in all its effulgence, and justify the inspired writer in fixing its creation on that day.

If this were not so, this *light* must be understood, as St. Augustine explains it, in a spiritual sense, as referring to the creation of angels, or as belonging to the sun, though yet in such a way as that its influence was little felt upon the earth until the fourth day. In all these cases, and they are the only ones that can well be supposed, the literal meaning is the only rational interpretation which can be given to the text; for in this case only could the vegetable world exist until the fourth day. If, on the contrary, those days are to be taken as indefinite periods, geologists are bound to prove that the sun's influence *did* extend to the earth during the first, second, and third days; that the sun, moon, and stars, which Moses affirms to have been created on the fourth day, were, notwithstanding, in the full and perfect exercise of their respective functions during all the previous days; and that the words of the inspired writer, instead of admitting a literal or figurative meaning, were contrary to fact, and, consequently, entitled to no credit or consideration.

"The sun's rays," says Sir John Herschel, "are the ultimate source of almost every motion which takes place on the surface of the earth. By their heat are produced all winds, and those disturbances in the electric equilibrium of the atmosphere, which give rise to the phenomena of terrestrial magnetism. By their vivifying action, vegetables are elaborated from inorganic matter, and become, in their turn, the support of animals and of man. By them the waters of the sea are made to circulate in vapour through the air, producing springs and rivers. By them are produced all disturbances of the chemical equilibrium of the elements of nature, which, by a series of compositions and decompositions, give rise to new products, and originate a transfer of materials. Even the slow degradation of the solid constituents of the surface, in which its chief geological changes consist, and their diffusion among the waters of the ocean, are entirely due to the aberration of the wind and rain, and the alternate action of the seasons; and when we consider the immense transfer of matter so produced, the increase of pressure over large spaces in the bed of the ocean, and diminution over corresponding portions of land, we are not at a loss to perceive how the elastic power of subterranean fires, thus repressed on the one hand, and relieved on the other, may break forth in points where the resistance is barely adequate to their retention, and thus bring the phenomenon of even volcanic activity under the general law of solar influence."*

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* Herschel's Astronomy, p. 211.

If geological theories must needs be adopted, then all these effects had been produced previously to the fourth day by the dim sun-light—if so it can be called—which reached the earth; or the sun's rays, in their unimpeded splendour, must have shone upon our planet long anterior to the time pointed out by the inspired writer. One alternative throws upon geologists the *onus* of proving that "even volcanic activity" might have been effected by mere light, without the sun's rays; the other places Moses in the unenviable position of one who cares not or knows not what he writes.

This is the obvious inference to be drawn from geological theories, whatever be the motives of those who support them. The Eocene, Miocene, and Pliocene periods of Lyell, are evidently directed to this end, as they include "countless ages" of animal and vegetable existence, previous to the creation of man. Nor does he limit these to the countless ages of past time; no, he extends their future existence to "myriads of ages yet to come;" nay, seems to contemplate no termination to animal and vegetable life, as he scarcely allows them a beginning.

Some philosophers, Lyell included, argue as if the ultimate object of the creation was only to perpetuate organic life upon earth, and fit it to the varying conditions of our planet. Their anxiety to prove the existence of animal and vegetable life upon earth, previous to the creation of man, during periods of immeasurable length, fully justifies this allegation. Such an object would be unworthy of the Creator, and was quite foreign to His views in producing this visible world. His own glory was His first object, and as man is the only visible creature from whom He could receive this glory, He created all inferior creatures for "man's use and benefit." Hence, the existence of those creatures for myriads or millions of years previous to man, would not have answered the proposed end. In Lyell's geological epochs, and successive creations of organic beings, he seems to ignore Scripture altogether. The Mosaic narrative is not regarded in his tertiary periods, and in combating the opinions of other writers, the New Testament is discarded with as little ceremony. "We perceive clearly," he writes, "from his (Ray's) writings, that the gradual decline of our system, and its future consummation by fire, was held to be as necessary an article of faith by the orthodox, as was the recent origin of our planet."* If we are to infer from this passage that he has no faith in a future general judgment, and the consummation of all terrestrial things by fire, we should not be surprised at the little deference which he pays to the Mosaic account of the creation.

It may be well to remind those who are anxious to reconcile Scripture and geology, and who, in order to effect this reconciliation, are willing to grant the existence of plants and animals previous to the work of the six days, considered as ordinary days of twenty-four hours, that such concessions are not required, and that existing phenomena can be accounted for without making admissions in favour of theories unsupported, as they are, by science or natural history.

Were we to grant that organic beings occupied the earth long anterior to the work of the six days, we should also admit the doctrine of successive creations, as the Scripture narrative distinctly alludes to the creation of the existing races of the fifth and sixth days without any reference whatever to the supposed previous races. And if we admit the principle in one instance, where can we mark its limits? We cannot confine it to one or two ancient distinct races, and, consequently, we should adopt the geological theory of successive creations in its widest signification. As it has been shown that such a state is not warranted, even by geological facts, and is contrary to the plain and obvious meaning of Scripture, we can make no such concession.

Extinct races formed no system of organic beings, as they should have done had they been distinct creations. At present birds and fishes prey on insects; insects feed on birds and beasts; and tribes of land animals live almost exclusively on fishes. This circulatory dependence on each other, shows that each distinct creation of organic beings should constitute a system as well as those which now inhabit the earth. Ancient causes do not, according to Lyell's remark, differ from modern causes. As the visible creation was then what it is now, the plants and animals should have been similar; but as recent plants and animals form systems, so, also, should ancient plants and animals, had they been distinct creations. But the fossils of extinct races show them to have formed no perfect system; nay, they indicate relationship with existing tribes, and, consequently, we are not called upon, either by fact or argument, to admit the distinct creations of those extinct races.

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* Principles of Geology, p. 52.

Distinct creations cannot be admitted without also admitting the geological ages of strata, as geologists determine the antiquity of strata by the fossils which they contain. Were we to grant these, where could our concessions terminate? Neither the tertiary periods of Lyell, nor the epochs of the secondary or primary formations, could mark the limits; and the eternity of matter, or its sudden creation by Infinite Power, could alone, finally, terminate such admissions. The former no Christian will admit, and in the latter case, what boots it whether this creation took place six thousand, or six hundred thousand years since, as in either case a previous eternity had passed away, and creation at some time was recent? Why not admit the Mosaic narrative, then, as no theory framed by human ingenuity can be found, so rational, so scientific, or so satisfactory?

CHAPTER XXI.

Original state of the earth—Simple substances—Compounds—Physical changes by the influence of the sun—Immutability of continents—Sun-light and vegetables—Ancient and modern causes—Internal heat—Water above the firmament—Fifth day's creation—Insects—Reptiles—Birds—Connexion of the various orders of creatures—Human fossils—Radiation of plants and animals from centres—Geological distribution of plants—South America—Canaries—Australia and African Islands—Geographical distribution of animals—Asia—America—Madagascar—Brazil—West Indies—British Islands—Great saurians, &c.—Marine plants and animals—Peculiarity of distribution—Canadian lakes—Extinction of organic races—Geological facts and geological theories—Reconstruction of animals—Habits of animals—Similarity of structure and appearance, not proofs of identity of habits—Examples—General character of genera inapplicable to species of these genera—Examples—Geographical distribution marked by specific differences—structure insufficient to determine the habits of animals—Siberian relics, &c.

How long "the earth was void and empty, and darkness was upon the face of the deep," we have no means of ascertaining; but, during that period, and for the first and second days, we are assured by the Sacred Text, that the waters of the ocean prevailed over the surface of the earth. On the third day, the dry land appeared, and the waters that were under the heavens were gathered together into one place, and called seas. And the earth was commanded to bring forth the green herb, and such as may seed, and the fruit-tree yielding fruit after its kind, which may have seed in itself upon the earth. And it was so done.*

The separation of the waters under the firmament from those above it, is, perhaps, the only physical act to which we can refer during the first and second days; nor can we, otherwise than by conjecture, know the precise meaning of those words. Probably, allusion is made to the waters which the atmosphere absorbed from the surface of the deep, and held in solution or in vapour. The degree of heat required to assist this operation, we may presume to have existed in the atmosphere even without the theory of a central heat.

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* Genesis, i, 9, 10, 11.

Whether the Almighty, in the act of creation, produced the simple substances, and, subsequently, caused them to enter into all the combinations necessary to form existing bodies, or whether these combinations, and the compound bodies which they form, were coeval with the act of creation, we cannot determine. The latter, however, is the more probable supposition, as we are told that " the spirit of God moved over the waters," previously to the creation of light. From this we may infer, that water, which is a compound body, had existed before the work of the six days commenced. The atmosphere, also a compound body, had existed before light was made, and was probably undergoing some essential alterations until the fourth day: as if, on the first, it was dense and chaotic, on the second, capable of sustaining in vapour or in steam the " waters above the firmament," and on the third day, fit to support vegetable life. The solid materials of the earth, which, for the most part, are compounds, had certainly existed before the work of the six days commenced; and as no notice is taken by the sacred writers of the elaboration of compound bodies from their simple substances, we may justly presume that the elementary materials of the visible world entered into all their combinations at the instant the *fiat* of the Creator produced them from nothing.

The dry land, which appeared on the third day, could not have been raised from the bosom of the deep, by those natural causes to which geologists attribute its formation. Its peculiar amount, which could be neither greater nor less than what it is, without serious inconvenience, could not be the result of mere mechanical action. Its sloping tendency towards the sea, in all directions, as well in islands as in continents, bespeaks the most evident design in its formation, thus rendering it a fit habitation for man, and the creatures formed for his use. Islands and continents seem, as it were, the summits of vast eminences, which gradually slope down to the deepest abysses of the ocean. The vast mass of water which occupies these depths, can never alter these continental bases, against which it ever rages in vain. The summits of these vast elevations may be affected, but their foundations are perfectly immovable; and were the existing islands and continents worn down, no new ones could possibly be formed, as the deep basins in which the ocean reposes, could not be filled up by ten times the quantity of matter which is now above the level of the sea. The destruction of old continents, and the re-construction of new ones, are but the idle chimeras of speculative theorists; for, the power which could destroy the existing dry land, being always *invariable,* would ever prevent the formation of new land, by the agency of those causes which, though in full operation, had been unable to preserve the pre-existing continents from destruction.

The existing continents have not been upheaved by volcanoes; for, however violent might have been the convulsions of nature at any former epoch, the evidence of design is too manifest in the relative proportions of land and water, to suppose them the result of chance or accident. No; the Almighty Creator produced them at once by a single act of his all-powerful will; and the *form*, *amount*, and *position* of each great division of land, are precisely such as best suited the wants of his creatures.

This formation of land was a part of the third day's work, and its instantaneous production more strikingly displays the wisdom and power of the Creator, than if it had been the result of an almost infinite combination of circumstances in the lapse of indefinite ages. The Almighty, it is true, could have raised the dry land from the depths of the ocean by the agency of natural causes, and the effects be still miraculous; but as Scripture and the laws of nature concur to prove the third day to have been but of ordinary length, it follows that no natural agents, without the special interposition of Heaven, could have raised the present continents in that brief period.

As the sun's influence on the earth cannot be supposed to have commenced before the fourth day, how dreary would have been the third day, had it been a million or a myriad of years, or even a thousand or a hundred years in length! No central heat, had such existed, no dim sun-light, no chemical rays, could supply the place of the cheering sunbeam; and vegetable life would have been extinct before the dawning of the fourth day. Perhaps we should not include those humbler classes of vegetables which live in the deepest seas, or which grow and flourish in the recesses of the mine, or deep in the bowels of the earth. But surely those higher orders which require all the helps which soil and climate can afford, which are stripped of their verdant clothing by the partial withdrawal of the sun's presence, and again arrayed in all the beauty and bloom of spring by his periodical return—these could not subsist during one of the long geological epochs, deprived of the light which this vast luminary imparts.

Lyell affirms that " a false theory seems to be involved in the term *modern causes,* as if it could be assumed that there were *ancient causes* differing from those which are now in operation."* This very just remark forbids the assumption of any former heat on the surface of the earth greater than the present, whatever may be its source. *Even though the existence* of a central nucleus of liquid fire were admitted, it could not supply the sun's heat, as the equatorial volcanoes demonstrate. Those high mountains, with a vertical sun, and incandescent masses within, are yet involved in eternal snows. The polar regions, too, even at the level of the sea, with internal heat sufficient at the depth of two miles to boil water, (as some modern geologists affirm), are, nevertheless, involved in seas of ice and fields of snow which no existing heat can dissolve. What, then, would have been the condition of the earth had the first three days been indefinitely long, and no sun to shed its influence over its surface? But let the third day be what the faithful at all times supposed it, and what the natural meaning of the text declares it, and all the difficulties attending the long cheerless days of geologists will vanish, and all idle theorising be totally unnecessary.

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* Geology, vol. vi, p. 277.

The separation of the waters under the firmament from those above it, though seemingly the natural result of atmospheric action upon the ocean, is not without its import. This water, whether raised by natural or supernatural means, was evidently designed to supply the vegetable world during the third and fourth days, and the fresh water fishes of the fifth, and we may add, the other terrestrial animals of the fifth and sixth days, until the action of the sun on the waters of the sea could have furnished the necessary supplies; an event which, in the natural order of things, could not have been effected for several days. Had the days of creation been indefinitely long, the waters reserved above the firmament would have been *insufficient* for the vegetables of the third day, and unnecessary for the fifth and sixth, as the sun would have raised from the ocean on the fourth day, abundant supplies for the days to follow. In this case the inspired writer could have had no object whatever in noticing this water, which was reserved in the firmament. In a philosophical point of view, the literal meaning is rational and scientific, the figurative meaning inconsistent with the laws of nature. In a religious point of view, the literal meaning accords with the feelings and traditions of the faithful of all ages; the figurative meaning is indefensible, and repugnant to those feelings.

On the fifth day, "God created the great whales, and every living and moving creature, which the waters brought forth, according to their kinds, and every winged fowl, according to its kind." And on the sixth day, the earth was commanded to bring forth "cattle and creeping things, and beasts of the earth, according to their kinds."*

As no special mention is made of insects, we have no precise time to which to refer their creation, but there are several reasons for believing that, at least, many tribes should be ranked with the "creeping things" of the sixth day. Hence, from the close connexion of the different classes of animals, that the fifth day, and consequently all the other days, were but of ordinary length, and not indefinite periods of myriads or millions of years.

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* Genesis, i, 21, 24.

The numerous tribes of insects, which in the earlier stages of their existence are actually "creeping things," must have been called into existence on the sixth day. There are, at least, three hundred species of caterpillars known. These creeping things change their forms, and from the chrysalis or aurelian state, become inhabitants of the air. Have we not a right to rank them with the sixth day's creation?

Parasitic insects, which belong to the family of *acaridæ*, are found in all countries upon dogs, oxen, and other animals; and the *tabanus* of Linnæus seems the natural enemy of beasts and man. The proboscis of some insects is admirably fitted to draw blood. Beetles of various sorts, and different species of other insects, perceive, at a considerable distance, the smell of ordure and dead bodies, and resort in swarms to the places in which they are, either for the purpose of procuring food, or depositing their eggs. Great numbers of insects are entirely rapacious. The larvæ of the genus *dermistes* feed on decayed animals. And the genus *silpha* feed almost exclusively on dead carcasses. The larvæ of the *œstri* deposit eggs in various parts of the bodies of cattle, which, when hatched, produce the most painful tumours. Some lay their eggs under the skin of cows or oxen, which they perforate for that purpose; others enter the intestines of horses; others again deposit them in the nostrils and skin of sheep, deer, and on those parts of horses which are most likely to be licked with the tongue, and are thus conveyed into the stomach. The larvæ of the large horse-bot attain their full growth in May, and are coming from the animal from the end of that month to the end of June. The operations of the small horse-bot are not less remarkable. The genus *culex* (the gnat) subsist on the blood and juices of large animals, which they suck by means of their proboscis. It is almost needless to remark that the genera *pediculus* and *pulex* live by extracting animal juices. Hence, it is evident from these examples, and from the many others which natural history affords,* that all these tribes of insects *must have been created* on the sixth day, when the animals on which they were to prey received existence.

Now if all those insects which entirely, or in part, subsist on terrestrial animals, were created on the sixth day, it is just to infer that *all* insects were created on that day, and if so, the fifth day could not have been indefinitely long, as the fishes and birds, which feed on insects, could not subsist so long without food. Swallows are supposed to live exclusively on insects;—how could they have lived until the sixth day, had the fifth been one of our geological epochs? If insects were created on the fifth day, *they* could not have remained until the sixth, had these been other than ordinary days. Even if we suppose that some tribes of insects were created on the fifth day, and others on the sixth, we cannot, consistently with reason, or the laws of nature, suppose these days as indefinite periods; for we find these very tribes which may appear to have belonged to different days, mutually preying on each other, and acting the parts of *checks* and *counterchecks.* In every point of view, the literal meaning of the Scripture narrative appears to be the only rational or even possible interpretation which can be given consistently with the laws of nature, or the phenomena of the visible world. As birds partly subsist on the insects they devour, and insects feed on birds and beasts, their creation could not have been separated by any long interval.

That the whole worm tribe, *annelidæ*, the slug, snail, and the other reptiles, belong to the creeping things of the sixth day, is evident; and no argument to invalidate this conclusion can be drawn from the classification of these creatures by naturalists. Cuvier has united several *orders* of the classes which inhabit the different elements, to constitute the subkingdoms of his system: thus, the *whale, elephant,* and *eagle* belong to the *vertebrata*; the *snail* and the *cockle,* the *slug* and the *mussel,* to the *mollusca.* The greater part of the molluscs of the order *pulmonea* live on land. The family *limacidæ,* to which common slugs belong, differ very little from the family *helicinæ,* or the snail. The organization is nearly the same, the shell of the snail-tribe being the leading distinction. These are, undeniably, terrestrial animals; and however they may resemble the aquatic orders of this family, they certainly cannot be ranked with them in the order of their creation, and should be considered as quite distinct from those molluscs which are to be numbered with fishes.

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* Encyclopædia—Entomology.

As these terrestrial creatures must be named with the creeping things of the sixth day, whole tribes of the feathered race would have been without food had the fifth day been of more than ordinary length. The condor of the Andes and the Alpine vulture are carnivorous, and derive their chief support, not from birds, or fishes, or insects, but from carrion and small quadrupeds. The bearded eagle or lammergeyer subsists on chamois, hares, marmots, kids, and particularly on lambs, as its name implies. The secretary-falcon, a native of Southern Africa, would seem to have been destined by Providence to confine within due limits the race of serpents, so numerous in the districts which this bird inhabits. It attacks and kills the smaller ones, and feeds on them without danger. The vulture of Egypt and other southern countries lives on carrion. Rats, mice, field-mice, and other small quadrupeds, supply owls and many species of the eagle tribe with food.

Natural history furnishes numberless examples that the tenants of the air feed on the beasts and creeping things of the earth, and there are not wanting many cases, too, in which the latter retaliate on the former. Foxes, wild-cats, squirrels, and many other small animals, as well as some tribes of serpents, live almost exclusively on birds. Thus, the existence of creatures formed on the fifth day, seems to depend on the coexistence of others created on the sixth day, and vice versa; *facts* which *directly prove* that their creation could not have been separated by any extraordinary length of time, and, consequently, that those days were but of ordinary duration. Indeed, the mutual dependence of the different classes of organic beings on each other; their wonderful connexion; the admirable system which the visible world exhibits; all *demonstrate* the truth of that interpretation which modern infidelity designates as a "vulgar error;" and were further proofs of this required, geology itself will be found to furnish the most unexceptionable.

"Since it appears," says Dr. Buckland, "that the most ancient marine animals occur in the same division of the lowest transition strata, with the earliest remains of vegetables, so that the evidence of organic remains, as far as it goes, shows the origin of plants and animals to be *contemporaneous;* if any creation of plants preceded that of animals, no evidence of such an event has yet been discovered by the researches of geology."* As conclusions hostile to Scripture have been deduced from organic remains by geologists, without even qualifying their evidence by words couched thus, "as far as it goes;" it is just on our part to use similar evidence, without any modification, in proof of our views; and hence we infer, that if the third and fourth days had been indefinitely long, the creation of plants *would have preceded* that of animals by a considerable period, which, however, *is disproved by geological research,* and, consequently, indefinite periods and geological eras, applied to the days of creation, are not sanctioned by Scripture, natural history, nor even by the facts of geology.

No human fossils are said to be found in the earlier strata in which the remains of plants and animals exist; and hence, geologists infer the antiquity of extinct races. Is it not just, by a parity of reasoning, to infer that plants and animals are coeval, as their relics *are* found together in the earliest secondary strata; and, further, to conclude, that as plants and animals are coeval, the days of creation could have been no other than ordinary days?

Plants and animals seem to have been distributed at their creation, according to a certain law by which every species of each kingdom may be referred to a centre from which it has radiated. This at once shows us the tendency of nature to simplicity and unity in the origin of things,* and the influence which external circumstances exercise through every department of animal and vegetable life. This radiation, or spreading from a centre, extends on all sides to greater or less distances, according to circumstances;—in the vegetable world, according as each species is more or less capable of overcoming the adjacent species by its relation to the soil and climate; in the animal world, according to their powers of subduing foes. That this distribution has been made, will appear from the following facts, selected from unexceptionable authorities.

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* Buckland's Geology, vol. i, p. 18.

Humboldt and Bonpland state, that in all their travels through South America, they found only twenty-four species of plants common to the old and new worlds. De Candolle observes, that out of 2891 species of *phanerogamic* plants described by Pursh, as existing in the United States, there are only 385 which are to be found in Northern Europe. According to Brown, of 4100 species of plants discovered in Australia, only 166 were common to Europe; and of this small number, some were probably carried thither by emigrants. Most of the others belonged to those kinds which are provided with the most ample means of dispersion to vast distances.

In the Canaries are reckoned 533 species of plants, of which 310 are said to be peculiar to those islands, the rest being identical with those of the African continent. But in the flora of St. Helena, among 61 native species, only two or three are found to exist in any other part of the world. Of the family of the *protaceæ* alone, 23 genera have been found in Australia; while not more than two of these genera occur in either of the southern continents. Of the leafless *acaciæ*, 107 are known; 100 of these belong to Australia exclusively. Of the other seven, five are natives of the tropical islands of the southern hemisphere, and one, of the Sandwich Islands. Of twenty-two American genera of palms, only seven are found elsewhere; and on the other hand, only ten other genera appear in the Old World. Of the palms of New Holland, all the species are peculiar to it, and all those growing wild in the Isles of France and Bourbon are not found elsewhere. *Phœnix dactylifera* seems peculiar to the west of Asia and to the interior of Africa. *Crucifera thebaica* has hitherto been only found in Upper Egypt and Arabia, and *chamærops humilis,* in the south of Europe and north of Africa.

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* Cardinal Wiseman's Lectures on Science and Revealed Religion.

Among animals the same peculiarity of distribution is yet more apparent. The elephant of Asia is altogether distinct from that of Africa. The Asiatic orang-outang is quite different from the African chimpanzee, and similar distinctions exist between most of the other quadrupedal species. In Africa there are thirteen peculiar genera of quadrupeds; three are peculiar genera of quadrumana, and three of the lemur or bat tribe The quadrupeds of Australia, amounting to fifteen or sixteen genera, are all peculiar to that region; those of America are almost all exclusively peculiar to that continent. The Island of Madagascar contains four genera of peculiar quadrupeds.

Birds, notwithstanding their great powers of locomotion, form no exception to this general law of distribution. We find one assemblage in Brazil, another in the same latitude, in central Africa, a third in India, and a fourth in New Holland. Some are so local, that in the same archipelago, a single island often contains a species found in no other part of the globe. The American parrot has nothing in common with that of Africa; and neither, with that of India. The whole tribe of humming-birds belong to America, and even there some species have a very limited range, not extending beyond the West Indies. Birds-of-paradise are not found out of New Guinea. Southern Africa has twenty-two genera of birds peculiar to that country; and Australia, nearly as many. Madagascar also contains many peculiar species, and the ornithology of the British Islands affords an illustration of this law in the common grouse, not to be found in any other region of the globe.

Of the great saurians, the gavial of the Ganges differs from the cayman of America, as well as from the crocodile of the Nile. The monitor of New Holland is distinct from the Indian species; this again from the African race, and all, from their congeners of the New World. America is the country of the rattlesnake, the llama, the rhea, the gymnote or electric eel; Africa, of the cerastes, the giraffe, the two-horned rhinoceros, the sun-bird, &c.; Australia, of the kangaroo, blackswan, ornithorhynchus; and Asia, of the hooded snake, or cobra-de-capello. Snakes and toads are found in England, but not in Ireland.

It is almost unnecessary to add, that marine plants and animals are subject to the same law of distribution. The examples of this law would fill volumes, but those above will suffice to justify the induction, that plants and animals were distributed at the creation, as soil, climate, and other circumstances favoured each peculiar species. The lichens and mosses, the rein-deer and polar-bear, which live amid the snows of the frigid zone, would be as little adapted to the temperate and tropical regions of the earth, as the orange and lemon-trees of Southern Europe, or the African lion or camel would be to those snow-clad summits, where scarcely a trace of vegetation exists, or a vestige of animal life is to be found.

But passing from extremes to regions which resemble each other in climate and natural features, we discover striking peculiarities in the organic kingdom. China is noted for its teas; Mocha, for coffee; the West Indies, for sugar; Hungary, for its wines; Kent, for its hops; and so of innumerable other places. Indeed, there would seem to be some things so peculiar in certain localities, that even manufactures can be brought to a higher degree of perfection in some places than in others, though workmen, materials, and all those external circumstances perceptible to man, were the same. These results are certainly owing to latent qualities in the air, water, or other elements used in the manufacture; and, perhaps, it is on this account, that certain animals, whose acute senses perceive what man cannot discover, are so attached, and, as it were, fixed to those haunts, from which, for many generations, they are seldom known to stray. Nay, some species are so peculiarly adapted, as if created for the situations they occupy.

The great chain of fresh-water lakes in Canada are inhabited by an immense variety of fishes, shell-fish, small amphibious animals, aquatic birds, &c., nowhere else to be found on the surface of the globe. The streamlets and lakes of the Kentucky cavern contain, we are told, a species of fish, and the cavern abounds with insects, deprived altogether of the organ of sight.* The species of fish called *prenadillas*, are found in subterranean lakes in the province of Quito, and are sometimes cast forth in thousands by the volcanoes of this region.† These examples prove that plants and animals were, at first, distributed to correspond with the physical condition of the globe. *Species* were then more numerous than they are now, though *varieties* and individuals are now more multiplied.

From this geographical distribution of organic beings we learn the important truth, that plants and animals may perish, and leave no analogous species after them on earth; and, from those natural causes which are in constant operation, we infer that whole families have been swept from the surface of the earth, and buried in its bowels. Had the Canadian lakes been destroyed before now by an earthquake, and their numerous inhabitants entombed in the ruins, and the strata examined by modern geologists, the fossils would be ranked with those of extinct species, and the animals referred to some remote era. Had the Kentucky caverns been formerly overwhelmed, and their singular fishes been recently discovered, what strange theories would have been devised to account for their existence! Probably, the absence of the organ of sight would induce our theorists to refer them to the period "when darkness was upon the face of the deep."

No fossil-remains can justify the conclusion, that extinct races are more ancient than the progenitors of those that now inhabit the earth; nor, that successive races have peopled the earth from the earliest periods. Many species are known to have outlived the most important revolutions which occurred in the physical geography of the earth, whence we may justly conclude, that such changes require no new creatures of different natures from those which had formerly occupied the locality, and which will be found to people again the altered district. But nothing justifies the doctrine of new creations; and Lyell's attempts to do so are trifling, and, in every point of view, unworthy of him.

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* Annals of the Faith, vol. v, p. 355.

† Phillips' Geology, vol. ii, p. 180.

The leading errors of geologists on this point, arise from false conclusions as to the nature and habits of extinct animals. "A mere tooth or a few scales," says Lyell, "is often sufficient for the recognition of a species."*

Such data may, perhaps, be sometimes sufficient to point out the order or genus of the species, but it can never suffice to determine a more important matter, namely, the nature or the habits of the species, and without this knowledge we can know very little of the animal. The celebrated Cuvier, who has done more for natural history than any other man, has been successful beyond expectation in actually reconstructing animals from imperfect skeletons, and even from single bones; but there have been cases in which all his talents and all his research have been unavailing, even in determining the family or class to which some fossils belonged. We may add, that in the instances wherein he has been most successful in the reconstruction of the animal, he could know very little of its nature or habits, save by mere conjecture. Hence, no arguments subversive of the Scripture narrative, can be fairly deduced from the fossils of extinct species.

The *ornithocephalus* is entirely a fossil genus, which Cuvier refers to the *amphibia;* Blumenbach ranks it with birds; Collini describes it as a fish; while Sœmmering ranks it as a bat with the mammalia. The Stonesfield fossil-jaws, which Cuvier and Owen refer to marsupialia, M. De Blainville thinks not to be those of mammalia. The fossil-monitor, found in the quarries of Maestricht, about ninety years ago, has ever since been a subject of discussion: some have described it as a crocodile, others as a whale, others again have arranged it with fishes; Cuvier ranked it with animals of the lizard tribe, and is of opinion it must have been an inhabitant of the ocean. Of two fossil species of hippopotami ascertained by Cuvier, one cannot be distinguished from the existing species.

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* Geology, book iv, p. 379.

Cases of similar uncertainty may be multiplied; and if the most distinguished anatomists could not determine even the class of creatures to which some of the fossils belonged, how much less could the genus or species be known! and were we even acquainted with these, how far still would we be from a knowledge of the peculiar habits of the animal! If the peculiar habits of an animal whose fossil is found in a particular region, cannot be determined, who can say that the habits of the animal were not fitted for the country in which its remains are found? Comparatively ignorant of the form of those extinct creatures, and totally so of their nature and habits, is it not the extreme of temerity to assert that they were distinct from existing races, and thence to conclude, that successive races occupied this earth from the earliest ages; that the laws of nature had been different in the geological epochs from what they are now; and that, consequently, such results could only arise from the immeasurable length of the days of creation?

We have already used so many arguments in refutation of such errors, that others would seem unnecessary; however, as too much cannot be said in disproof of opinions entertained at present by many geologists, eminent for their scientific acquirements, we cannot quit the subject without adducing other proofs to show, that no just reasons for supposing these vast geological epochs can be inferred from the fossils of extinct races, in whatever light we consider the subject.

If we are acquainted with the habits and geographical distribution of one species of a genus, can we decide on the habits and distribution of another species of the same genus? Geologists, without having fully investigated the subject, have assumed the affirmative. But to show that the question should be answered in the negative, it is necessary to consider its different bearings. 1. If two animals resemble each other in structure, will their habits be similar? 2. If two animals resemble each other in external appearance, will their habits be similar? 3. If two animals resemble each other in structure and form, will their physical powers and geographical distribution be similar? As regards the first question, we have to observe, that the comparative anatomist has traced a considerable resemblance between the skeleton of the hippopotamus and common ox, yet this analogy would not have afforded the slightest intimation of the aquatic habits of the former animal, to one who had no previous knowledge of them, although they constitute so peculiar a feature in the character of this animal.

If we place side by side the skeletons of the ermine, the pole-cat, and the otter, the general resemblance of these would at once be admitted; but observation proves how very different are their habits. The common bear and the arctic bear are as much alike in structure, as they are different in habits. Osteology even gives but very imperfect indications of external form in many animals. The round caudal vertebræ of the seal would not indicate the depressed tail of the animal; nor would the depressed facial bones of the whale indicate the remarkable fulness of the outline of the head. The mastodon may have had a proboscis like an elephant, from the general resemblance of the structure of both animals, and from the length of the legs and the slight development of the toes. But we should remember that the giraffe, with its head much farther removed from the ground, is yet able to obtain food without a proboscis; and that the dipper and hippopotamus are excellent swimmers, though seemingly very ill fitted for that exercise. From these facts we may infer, that animals may resemble each other in structure, and yet be very different in habits.

Why, then, should it be inferred from the fossil of an unknown animal, or from the fossils of a species or genus of an existing order, that the climate of a country has materially changed, or that ancient causes were quite different from modern causes? Though the fossils of ancient animals resemble those of existing species, it cannot be inferred that the habits of both were similar; and hence, it cannot fairly be affirmed that the habits of these extinct races were unsuited to the climates in which their relics are found. It is, therefore, highly unjust, as well as unscientific, to overturn the established laws of nature, in order to reconcile the supposed habits of an unknown animal to the climate in which its remains are discovered. If fixed laws are to be subverted on such vague and doubtful data, no theory, however rational, can be secure against the most fanciful speculation.

As regards the second question, it rarely happens that animals of different species resemble each other so closely, as that an attentive observer may not perceive distinctions. Some modifications of structure, or of form, are generally found in one, which cannot be seen in the other; and this difference in structure or form is, precisely, what influences its habits, though even in cases where the forms are most alike, we do not perceive the same habits. The habits of each species, therefore, and not the general character of the genus, must be studied, permitting analogy to assist, but not to guide us in the inquiry.

Examples may be found in every department of the animal kingdom to justify these remarks. The common shrew frequents old walls, and dry, grassy banks, while the water-shrew dwells on the margin of ditches, and swims and dives with ease. The common mouse is improvident, while the field-mouse is a storing animal, and susceptible of torpidity. How different are the habits of the rock-dove and ring-dove; the rook and the jackdaw; the heron and bittern! How different the solitary porpoise from the gregarious, wandering grampus! Equally different are the habits of the char, the sea-trout, and common trout. Wild animals and domestic animals of the same genus are widely different in habits. The Newfoundland-dog, the spaniel, the terrier, &c., are no less so.

Whether species of the same genus be considered in reference to food, places of retreat, relation to foes, instinct with regard to their young, &c., we find each exhibiting peculiarities of which we could have no idea from a knowledge of the habits of their congeners.

With regard to the third question, we find that every species has its own appointed place, influenced in all cases by the latitude, the temperature, and the physical geography. The tropical plains are, alone, agreeable to the zebra; the Tartary horse roams on the elevated plateaux of Asia; while the common horse can live throughout a polar winter. The buffalo delights in warm regions, and cannot live where the ox thrives, while the musk-ox prefers the stinted herbage of the arctic zone, and is able, by its periodical migrations, to subsist through the severest winters. One species of hare is fitted for Africa, another for the frigid zone. Thus, we perceive how each species of the same order or genus is controlled by its own laws; and hence, we infer that the most intimate acquaintance with the habits of one species, will not warrant us to judge of the habits or geographical distribution of another species with which we are unacquainted, however similar in structure and external appearance. If this is true with regard to existing races, how much more powerfully will it apply when referred to extinct animals, only known to us by a tooth, a bone, an imperfect skeleton, or a reconstructed figure!

The justice of these remarks must be evident to every impartial inquirer; geologists, however, have paid very little regard to them.* "On seeing the shoulder-bone of an animal," says Professor Ansted, "we see at once, from the form of that bone and socket, and the position in which it was placed, whether it was principally required to support a heavy weight, or whether it was so attached that it could be moved readily. If there was a certain projection in connexion with this socket, it prevented the animal from moving its fore-leg, with ready motion, forward. It could not have given a violent blow with its extremity; on the other hand, when the fore-paw could be moved readily in the direction, the presumption was that the animal required to use it in a similar manner as the lion; *therefore, the structure determined the habits.*" How imperfect must be our knowledge of the habits or geographical distribution of animals with such data, and how presumptuous, indeed, must it be to deduce arguments subversive of Scripture authority on such futile evidence! and yet, upon such evidence have many of the most important geological theories been established.

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* In reference to the extinct races of animals, whose habits and geographical distribution geologists pretend to determine with so much precision as to deem them data sufficient to overturn Scripture and the laws of nature, the remarks of Lyell, in combating the Lamarckian theory, are very applicable. "A large proportion," he says, "have never been seen alive by scientific inquirers. Instead of having specimens of the young, the adult, and the aged individuals of each sex, and possessing means of investigating the anatomical structure, the peculiar habits and instincts of each, what is usually the state of our information? A single specimen, perhaps, of a dried plant, or a stuffed bird or quadruped, a shell without the soft parts of the animal, an insect in one stage of its numerous transformations;" (and we may add, a single bone, a tooth, or a supposed foot-print), "these are the scanty and imperfect data which the naturalist possesses." Vol. ii, p. 432. Upon these scanty and imperfect data, which

"The megalosaurus," he says, "was exceedingly carnivorous, known by a few fragments of the jaw, and portions of the extremities. These bones indicated an animal larger, perhaps, than the largest crocodile, though differing much from the proportions of that animal; for, while the largest crocodile could hardly be higher than four feet, the megalosaurus would be quite as high as a hippopotamus, and, perhaps, in appearance resembling the elephant." Thus the learned lecturer conjures up animals which probably never had existence save in his imagination; and similarly have other geologists constructed animals stranger still than the megalosaurus, and on their supposed existence, devised theories which many foolishly prefer to the narrative of Moses.

Among the numerous organic-remains which have been found in the temperate and arctic zones, an elephant and a

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Lyell urges with so much ability and justice, in disproof of the Lamarckian hypothesis, the theory of successive creations and geological epochs are founded by modern geologists, including Lyell himself, who seems to forget, in his zeal against Lamarck, that no arguments based on the habits, instincts, or geographical distribution of extinct animals, can be admitted on these "scanty and imperfect data."

rhinoceros, in a comparative state of preservation, may be mentioned. Such animals, at present, live only in the warmest regions of the globe. If these relics belonged to existing species, they must have been transported thither by some unknown means; if they were indigenous to the country, the climate must have undergone some extraordinary alteration. This conclusion is conformable to the truths of zoology, as the knowledge of the habits of individuals is equivalent to a knowledge of all that species.

But if the relics in question belonged to a different species from those which are now in existence, though of the same order or genus, then we can neither conclude that these animals were transported thither, nor that the climates in which their relics are found, underwent any considerable change.

Now, according to Cuvier, the mammoth of Siberia was specifically distinct from the elephant of India, and hence, it cannot be inferred that they were transported to where their remains are now found by any extraordinary means. Besides, it appears, that those fossils, so abundant in Siberia, diminish in quantity as the latitude decreases, although the very reverse may be naturally expected had the animals passed from India to the northern regions. In fact, such relics are not at all found within the geographical limits of the existing species. All these circumstances tend to prove that the animals lived in the countries where their relics are found, and, consequently, their habits were suited to the climate. At all events, neither fact nor science gives us any reason to suppose that the climate was suited to the habits of the elephant of India, as the advocates of a central heat would fain persuade us.

The carcass found near the mouth of the Lena, on the shores of the Arctic Ocean, has afforded decided proof that the climate of Siberia, when the animal perished, was the same as it is now. The skin did not present the scaliness of surface and naked appearance which characterize the living elephant of the southern regions. The very reverse was the fact; for it was covered with black bristles, from twelve to fifteen inches in length, and thicker than horse-hair; reddish brown hair, about four inches long, and fine wool, of the same colour as the hair, one inch long. This covering argues no tropical climate; but rather one similar to that which the musk-ox inhabits. The carcass of the rhinoceros found by Pallas in 1770, also gave indications, by its hairy covering, that its habits were suited to the zone in which it was found. From these facts it is evident that these regions were once inhabited by such animals. Indeed, innumerable remains which are found of their skeletons, can leave no doubt of this. The following example, in our own days, will show that the preservation of these ancient animals in ice, and the manner of their death, contain nothing out of the common course of events natural to such cold climates. "Whilst we were crossing Mouren-Ousson* upon the ice," says Rev. E. Huc, "a singular spectacle presented itself to our view. We had already descried in the distance sundry shapeless objects, which seemed embedded in the ice in the middle of this great river. What was our astonishment when we recognised more than fifty wild oxen, which, no doubt, commenced swimming over at the moment that the water froze; their huge heads, surmounted by monstrous horns, were uncovered; the rest of the body was griped in ice."† The monsters preserved in ice in Siberia must have similarly perished; a fact which affords additional proof that they were natives of this district. Two objections, however, require to be answered; one, how creatures of such magnitude could have been supported in the wilds of Siberia; the other, by what means the whole race was destroyed, without leaving a single individual alive of the thousands which once occupied these regions. These points shall be duly considered in the following chapter.

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* The name of the Blue River, in Thibet.

† Annals of the Faith, vol. x, p. 263.

CHAPTER XXII.

Different habits of animals of the same species—Forests of the North—Mastodon—Changes of climate by changes in physical geography—Era of the mammoth, mastodon, &c.—Latitudinal range of the palm and modern elephant—Vegetables fostered by man—Indigenous plants—Theories to account for supposed changes of climate—Objections—Data on which proofs of extraordinary changes are founded—Ancient state of our rivers, forests, lakes, seas, &c.—Axis of the earth's rotation variable—Objections of astronomers—Effects arising from shifting of the earth's poles—Objections—Changes of climate accounted for—Animals in the ark of Noah—Their subsequent dispersion—Natural order suspended—Examples—Dispersion assisted by natural causes—Examples—Shells in the Andes—Inferences—Geological facts, in reference to modern theories and the Scripture narrative, &c.

No one acquainted with the habits of the fallow-deer, the stag, or the roe, and ignorant of those of the reindeer, could imagine the latter animal capable of subsisting on the mosses and lichens of Lapland. Why, then, should it be deemed a matter of surprise if one species of elephant could subsist in Siberia, while a different species can now be only found in the regions of the torrid zone? There is reason to suppose that the physical condition of Siberia was somewhat altered at the deluge. Iceland contained trees of great size since the period of the Noachian deluge, though none but stunted birches and dwarf pines are now found there. Siberia and Spitzbergen may also have contained extensive forests, and whatever revolution could have destroyed these, could also have annihilated those huge animals.

Professor Jones describes the stomach of the mastodon as containing "large bushes ground up by its mammaliated teeth, and swallowed whole;" and again, as being "filled with bundles of sticks, which its teeth were enabled to break up and swallow." As we have no reason to suppose the stomach of the mammoth to have been more delicate than that of the mastodon, we cannot conclude that Siberia, even in its present condition, could not have afforded subsistence, at least for some time, to those ancient animals which inhabited it.

Changes in physical geography will produce corresponding changes in climate and natural productions. The Nile has made Egypt a fertile land, and were its waters to flow westward through the desert, Sahara would become habitable, and Egypt be changed into an arid waste. The forest grounds of N. America are converted into fruitful fields by cutting down the trees, while a similar process, in warm climates, has in many cases produced a contrary effect. A deep gulf, or an inland sea, would materially alter the physical constitution of Africa, while the swampy marshes of America or Italy could be reclaimed by effectual drainage.

As the latest deposits containing palms, arborescent grasses, and tree ferns, are the *tertiary strata*, which geologists suppose to have been formed long before the creation of existing organic beings, it follows, that after the completion of the latest tertiary formation, the temperate and arctic zones were no longer fit for the production of those tropical plants. But they were not, it seems, unfit for the elephant, rhinoceros, mammoth, mastodon, tiger, hyena, &c., for these animals are allowed by many eminent geologists to have been indigenous to the countries in which their remains are found, down to the period of the deluge. " From all the facts before me," says Professor Rogers, " I have little hesitation in giving my opinion that the extinct gigantic animals of this continent, (North America), the mastodon, elephant, megalonyx, megatherium, fossil-bos, and fossil-cervus, lived down to a comparatively recent period, and that some of them were in existence so long ago as the era anterior to that which covered the greater part of this continent with diluvium."

Thus, an immense period would have elapsed between the extinction of the animals, and the forests and jungles which could have furnished them with food and shelter.

Now, if these animals could have lived in countries where no tropical plant could flourish at the time they occupied it, what necessity is there for supposing such changes of climate as no *modern* cause can warrant? Either, then, the extinct plants and animals of these regions were coeval, or the animals could live there long after the plants deemed so necessary for their support had passed away. If both were coeval, then the remote tertiary periods of geologists will turn out to be no earlier than the period prior to the deluge, when the animals existed. If the animals existed there long after the plants became extinct, then it is plain that these animals required no tropical climate, and that no necessity exists for supposing any former high state of temperature, arising from a central heat, or from any other *ancient causes*, different from those now in operation.

Professor Rogers states, that *some* of these animals lived in the period anterior to the deluge; had he said *all* of them, his opinion would have been correct, as there can be no doubt of their existence during the antediluvian period, and of their destruction, principally, in that awful catastrophe. Several species of vegetables, too, must have become extinct by the effects of the deluge, and the remarkable changes in physical geography which it must have occasioned. But, under whatever phase we can view this subject, the inconsistencies of geological theories are apparent. Palms are now found in the South of Europe as far north as Nice, while the range of the elephant is more limited by ten degrees of latitude. According to geological theories, we would have animals living where palms and other tropical plants could not exist, and now we have these vegetables flourishing in latitudes to which the range of the elephant and the other animals of the torrid zone does not extend. This is in direct opposition to the results which modern theories would lead us to expect.

Those who assert that England once enjoyed a tropical climate, because the country contained animals and plants, not found there at present, draw their conclusions from insufficient data. We have noticed, elsewhere, the causes why animals have become extinct; here we shall only observe that they seem forgetful of the fact, that England and many other European countries were formerly covered with dense forests. Then various plants were indigenous to the country, which have disappeared since the dominion of man had been established. "No foreign plant," says Lyell, "though fostered by man, thrives with the same luxuriance as the native plants of a district; and it is only in a country not subject to man that *the native plants are known*." In countries not subject to man, plants are left, as it were, to select their own situations; seeds are borne in all directions by wind, water, insects, birds, &c., they grow and prosper where circumstances are favourable, and, hence, many flourish in countries where man's utmost efforts to produce them may be unsuccessful. Man's limited knowledge of natural causes may fail, where nature herself may be eminently successful, and so, in many instances, it actually happens. Hence, several species of plants have been extirpated by man. Animals, too, have given place to him. The wild boar, wolf, fallow-deer, roe, pole-cat, beaver, and the ancient breed of indigenous horses, have become extinct in England. Bears and lions have disappeared from Palestine, wolves from Ireland, and few countries are known, in which some animals have not become extinct in recent times; a proof that these countries might have been inhabited in more remote times by animals now unknown, though they had undergone no extraordinary change of temperature, nor any remarkable variations in physical constitution. Mr. Edwards states, that in the early part of the dry season, when turtles ascend the Amazon to deposit their eggs, the people for hundreds of miles around resort to the river banks as regularly as to a fair, and that no fewer than 72,000,000 eggs are annually destroyed, and still this is but a small portion of the whole number.

Several theories have been devised to account for the extraordinary circumstances which could produce so marked a difference between the present and the former productions of the temperate and arctic regions of the globe. A central heat, a change in the earth's centre of gravity, and, consequently, a shifting or change in the axis of rotation, whereby the position of the poles and equator would be altered, have been mentioned as the causes by many; whilst others ascribe all that has occurred to changes in physical geography, arising from the agency of ordinary causes.

Such effects could not have resulted from internal heat; for, if the earth's crust in the latitude of Siberia possessed only a degree of heat equal to that of the earth within the tropics at present, it could produce little effect on the surrounding atmosphere, whose warmth is as necessary for tropical plants as that of the soil in which they are rooted. And had the earth possessed heat sufficient to affect the atmosphere to the extent necessary, no vegetables could exist in the heated mass;* hence, the notion of an internal heat cannot be consistently entertained; and yet, some rational account must be given of those fossils whose presence indicates, too plainly to be mistaken, the changes which must have occurred in the different regions of the globe, though in most cases these changes have been exceedingly magnified by geologists.

Thus, they have inferred that our climate once enjoyed a tropical temperature; that our forests were impenetrable from the number of palms, tree-ferns, bamboos, club-mosses, &c.; that the dreary regions of the North, in which all nature seems spell-bound by the iron-hand of winter; where every quadruped wears a double coat of fur; whose shores are periodically deserted by the flocks of birds which sojourn there during the transient summer; that these regions were sufficiently mild for the elephant of India and for the crocodile of the Nile, as well as for palms and bamboos. But, however pleasing it may be to contemplate such scenes in by-gone days, it is, notwithstanding, very certain that these geological notions are exaggerations, unsustained by any authenticated facts; and that no changes, save those which alterations in physical geography are capable of producing, can be shown to have taken place.

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* The cold in Siberia is sometimes so great that the thermometer stands at 70° below the zero of Fahrenheit. The isothermal line in 72° north is at the freezing point. The line of mean annual temperature at the equator is 82°. The summer heat at Rio Volta is 95° in the shade, and 134° in the open air. In Senegambia it varies from 113° to 131°. Now, though the difference of the mean annual temperature of the frigid and torrid zones may not much exceed 50°, the difference of the extremes of heat and cold would be three times that quantity.

If we suppose the temperature of the frigid zone at some remote geological era to be what the torrid zone is at present, the torrid zone must have been proportionally hotter, as it must have been as much affected by the central heated nucleus as any other part of the earth's surface; in which case, it would have been totally unfit for the support of either animal or vegetable life.

The celebrated Hook, in his lectures in 1688, alludes to changes in the earth's axis. Ray also speaks of a "change in the position of the axis of the earth's rotation; of a shifting of the earth's centre of gravity:" their object in supposing such changes, was to account for physical changes in the phenomena of nature. The centre of the earth, as a globe or spheroid, may not be its centre of gravity. But, as the axis of rotation passes through the centre of gravity, and not through the geometrical centre, it follows, that any change in the centre of gravity would affect the axis of rotation, alter the position of the equator and poles, and produce a corresponding change in the climates of the earth. Were violent convulsions within the earth so to affect the whole mass as to cause *any* change in the centre of gravity, these effects would have been the result.

Sir Isaac Newton declares that "there was every presumption in astronomy against any former change in the inclination of the earth's axis." The objections of astronomers to this change, as "being incompatible with the laws of equilibrium," cannot be sustained: it is to maintain the equilibrium in the diurnal motion of the earth that the change is at all contemplated. And as regards the equilibrium of the solar system, it is certain no such fears could have been seriously entertained by astronomers, as many of them write as if they had comets at will to impinge against the sun, and strike off portions of that luminary; to shatter other planets, and send their fragments through space to describe other orbits different from that in which the planet, of which they had previously formed part, moved.* Professor Lindley has no scruples in adopting this hypothesis, as one which he supposed calculated to extricate him from the difficulties that attend the theory of geologists, in reference to the fossils of the temperate and frigid zones. But, though this theory is neither impossible nor improbable, nor anywise at variance with the laws of nature, of equilibrium, or of science, yet it is opposed to those geological facts which it was originally devised to explain.

Let us suppose this change in the earth's axis to have taken place, and that the poles of the equator were differently situated from what they are now—say 23° 28′ from the position they occupy at present; in this case the N. pole should be somewhere in the arctic-circle, and the S. pole in a corresponding point in the antarctic-circle. The latitude of the points in which the poles are now fixed would have been 66° 32′, and those points of the Polar-circles opposite the supposed poles, would have been as low as 43° 4′. The equator and ecliptic would, in such a case, coincide. If we suppose the N. pole to have been in the western hemisphere, Siberia would have been in a latitude sufficiently low to enjoy a climate fit for the palm and club-moss, as well as for the elephant and rhinoceros; but the frigid zone of that epoch would have embraced the Canadas, and extended to almost the 43° of the present latitude, in which case, we could expect no fossil of tropical regions in North America above the present parallel of 43°, or, we may lawfully add, above the parallel of New Orleans, which, in that state of things, would have been about 53½°, the present latitudes of the cold regions of Labrador.

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* Herschel ridicules the speculations of those who conjecture the ultrazodiacal planets to be fragments of some greater planet, which had formerly circulated in that interval, but was blown to atoms by an explosion, though he himself admits the probability of having one of the comets fall ultimately into the sun; he also affirms the planet Jupiter to be "a perpetual stumbling-block" to the comets, by retarding their motions, or turning them from their orbits; and yet, astronomers urge not against these opinions their incompatibility with the laws of equilibrium. Astronomers could only compare their own observations with those which were made subsequently to the deluge; they have no means of ascertaining the observations made previous to that period, and hence, there seems no direct *astronomical* proof that such a change has not occurred, though proofs of a different character may be urged against this idea.

Had we only to account for the fossils of Siberia, this hypothesis would seem unobjectionable; but when those of the northern portion of the New World are included in the category, the theory falls to pieces. The discovery of the mastodon, on the banks of the Hudson River, in 1801, and the many other tropical fossils of these regions, would require that the shifting poles would veer about so as to place the N. pole in Asia, or at least so far distant as to allow a climate to North America capable of admitting the growth of tropical plants, and fit for the mastodon and megatherium.

But as this shifting of the poles would depend upon changes in the centre of gravity and axis of rotation, and these again upon casualties subject to no law, the adoption of this hypothesis as a means to account for the presence of these fossils, would be as arbitrary as the most exceptionable theories of geologists; not because it is opposed to science or religion, nor because it involves anything absurd or impossible, but because we could suppose no fixed point for the N. pole, either in the Old or New World, without exposing the theory to be overturned by the discovery of a few fossils in the region opposite to the pole; and such a *shifting* of the poles as would, at one time, afford a tropical climate to Siberia, at another time, place the northern portions of North America in a very low latitude; and again include, as at present, much of the northern parts of both continents in the frigid zone. Such an hypothesis is as arbitrary as it is improbable, and no way calculated to explain difficulties far less intricate than those which it involves.

The changes in physical geography are the only rational means by which any alterations that have taken place in the climates of the earth can be accounted for. The agents employed in producing these changes have been rivers, oceanic-currents, earthquakes, volcanoes, hurricanes, and principally, the Noachian deluge. These subjects are treated elsewhere; here it will not be irrelevant to allude to a portion of Scripture connected with natural science, which has been so frequently cited by geologists as favouring their theory of successive creations, on account of its incompatibility with animal distribution, according to the natural state of the physical world. We refer to the manner in which the animals saved in the ark, were subsequently transported to the different places they now inhabit; and how the present geographical distribution of animals can be reconciled with the supposed wanderings of their progenitors, which were let loose on the plains of Asia-Minor, after the waters of the deluge had subsided.

To many, this presents a serious objection to the Scripture narrative, as it seems impossible that certain species of animals, peculiar to America, New Holland, and the islands of the Pacific Ocean, could have passed thither from Armenia, where the ark is supposed to have rested when the waters of the deluge retired from the surface of the earth.

It is true, that in the natural course of events, these animals could not surmount the difficulties to be encountered in passing from Asia-Minor to Australia or America. But this objection, startling as it appears, is one of the easiest of all those which we have undertaken to explain.

Previous to the deluge, the animal kingdom was as widely diffused as at any subsequent period; for, wherever vegetables existed, there, also, animals were to be found. Species were then more numerous than they are at present, the multiplication as great, and the distribution as general. The destruction by man was less, partly on account of the limited surface over which the human species extended in the early ages of the world, and partly on account of the prohibition of animal food; but the destruction later of animal life by floods, earthquakes, and other natural causes, was far greater.

If we view things according to nature, the difficulties which the animals would experience in going to the ark, would have been greater than in departing from it, for animals leave the haunts they love with reluctance, but return again with eagerness and delight. We are not, however, to look for nature in this phenomenon; an overruling Providence directed every movement. It was not by the ordinary course of nature that innumerable swarms of locusts and other troublesome insects covered the land of Egypt at the command of Moses; nor was it by this means that immense flights of quails entered the camp of the Israelites, while sojourning in the desert. Neither was it by natural instinct that the animals to be saved were gathered to the ark. Had nature anything to do in this, we may inquire why *all* the animals did not come as well as those which were saved. How they found the ark, and knew when to arrive. How they had crossed the deserts, seas, and mountains which intercepted their advance. How Noah could have seized, and forced into the ark, such a number of creatures, so averse to restraint, and so hostile to man. How Noah could have collected food for so many different kinds of animals, and for such a length of time. These, and a number of similar questions, may be asked, were we to look for natural causes; but as no such causes were required in congregating the animals in the ark, why should they be required in accounting for their subsequent dispersion? He who caused them to assemble, sent them back to their respective homes, and dispensed with natural causes on this occasion.

It would have been to no purpose to have saved them from the deluge, were they afterwards left to perish on the plains of Asia-Minor. The rein-deer of Lapland, the white bear of Russia, the sloth of Brazil, the kangaroo of New Holland, and the numerous tribes which inhabit other remote districts, could never have reached their destinations unaided by Him who suffered not those who accompanied him into the desert, to return home fasting, " lest they should faint on the way." He who sent them to the ark, was solicitous for their safe return. We seek not the order of nature in the circumstances of this interesting narrative, and, consequently, do not attempt to explain, by arguments drawn from natural causes, what must be inexplicable, save by the Divine interposition.

But, in noticing this miraculous intervention, we have no notion of superseding the aid afforded by natural agents in subsequently dispersing animal life through the different regions of the earth. How often have polar bears, and other animals of the North, been seen drifting along on ice, and arriving, by this means, on shores which they otherwise could not have reached! How frequently is the drift-wood of the Amazon, Mississippi, Ganges, and other great rivers, the means of conveying animals to vast distances from the haunts which their progenitors had long occupied! And animals which were naturally foes, have been seen side by side, peaceably resting on the logs which supported them, seeming conscious of their position. The minute eggs of fish are frequently entangled in the feathers of water-fowl, and when these alight to wash and plume themselves in the lakes of mountain-districts, the eggs are deposited in the water, and a remote lake is peopled, which otherwise would have been tenantless. Many water-beetles, in the evening, quit their lakes and pools, and flying in the air, transport the minute ova of fishes to distant waters, and supply small pools, caused by heavy rains, with the fry of fish.

Whirlwinds and hurricanes are often instrumental in transporting animals to distant regions.. They sometimes dry up lakes, and bear the shells and shell-fish to places far removed from the sea. Large heaps of sand, mingled with shells, have been borne by the winds to considerable heights above the sea-coast near Nice; and other mountain-summits, no doubt, have been supplied in a similar way. Shells are said to have been found in the Alps at the elevation of 13,000 feet, and in the Himalayas at 17,000 feet. Now, it is well known that the snow-line on the Alps is at about 8,000 feet above the sea, and on the Himalayas at about 11,000 or 12,000 feet; and how any shells could have been discovered at so many thousands of feet above the line of perpetual congelation, unless some few which might have been accidentally carried thither, we are at a loss to imagine; for, surely, no geological tourists could have examined the *strata* of these mountains, at such elevations, either so minutely or so extensively as to justify the conclusion that such strata had once formed a sea-bottom. Such marine or fresh-water remains must be referred to the deluge, to the fishes of temporary lakes, to hurricanes, water-fowls, or similar natural causes.

Beds of shells occur at various heights in the hills above the sea between Falcaguana and Concepcion, in reference to which, Ulloa says, "I was the more pleased with the sight, as it is to me a convincing proof of the universality of the deluge, although I am not ignorant that some have attributed their position to other causes; but an unanswerable confutation of their subterfuge is, that various sorts of shells which compose these strata, both in the plains and mountains, are the very same with those found in the bay."* This fact is conclusive against the arguments of geologists in favour of distinct creations of organic beings.

Either the existing races of animals were created subsequently or previously to the formation of the Andes;—if subsequently, then the shells above alluded to *must* have been deposited by the deluge, as Ulloa very justly concludes; for in this case, the Andes could not have been a sea-bottom when these deposits were made. If previously created, then we will suppose, with geologists, that these mountain-chains were upheaved long after the adjoining seas were tenanted with shells, and shell-fish, and marine animals of all sorts; and that the strata now so much raised above the level of the ocean, were formerly deposited at the bottom of the sea, and were subsequently raised by some extraordinary convulsion from the depths of the ocean, to constitute these snow-clad peaks, which seem as old as the waves which roll beneath.

Now, there are no revolutions in the physical geography of a district more calculated to alter its climate and natural productions than the sudden formation of mountain-chains, and geologists appeal to such changes as affording the strongest proofs that there *have been successive* creations of organic beings; "because," say they, "the altered condition of the region requires that new races of creatures be formed, with habits suited to the altered circumstances." But here we have, according to the supposition, one of the most extraordinary changes that could occur in the physical condition of this district, and yet no change in the organic beings, as the shells and the marine remains of the mountains and elevated plains are identical with those in the bay at present.

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* Ulloa's Voyage to South America, vol. ii, b. viii, chap. vi.

If, then, as we have supposed, the existing races of animals were created previously to the upheaving of the Andes, the facts detailed above show, that considerable changes in the physical geography of a district may take place, and yet no *new* races of animals be required to people it; a circumstance quite at variance with the geological theory of successive creations. The similarity of these fossils with the production of the adjoining sea, rather goes to prove that no change took place calculated to require any new races of beings, and that the fossils must be referred to the deluge, as the only agent by which they could have been placed in their present situation; and hence, every rational supposition which this case admits of, militates against the doctrine of successive creations.

The Mosaic account of the deluge, and of the six days' creation, in its plain and natural meaning, accords with all observed phenomena; while the geological system of the world is replete with inconsistency and romance. The simple and sublime relation of the sacred penman harmonizes with all the truths of science, as well as with the facts of geology. Light is created at first, as if to display to creatures the wonderful works which are to succeed. The firmament is next produced, and the different states in which water is known to exist, thereby manifested. This element, so necessary for the support of animal and vegetable life, is separated, the atmosphere holding as much of it as may suffice the organic kingdoms, until the sun's action on the waters of the ocean produced the necessary supplies. The heavenly bodies next shine forth in all their splendour, precisely at the time when their influence was required to make the vegetable kingdom grow and live, and produce seed according to their kinds. The animated kingdom springs next into existence; the food, and climates, and all the other necessary arrangements for the accommodation of living creatures, being made; and last of all came Man, as the ruler and governor of all that had been previously created. The relations established between the kingdoms of creation; their mutual dependence on each other; the connexion between the various subdivisions of the organic world; the links which unite all into one perfect system; all demonstrate that no long interval could have elapsed between the periods of their creation. This the sacred text declares; this the traditions and records of God's once chosen people, from the time of Moses up to this day, clearly corroborate; this natural history confirms; this the phenomena of nature proclaim, and this even the facts of geology establish. Then, shall theories based upon mere conjecture, speculations which would not be entertained in any department of science, or in the ordinary concerns of life—shall these indefensible theories and reveries be deemed sufficient to supersede the well-established and long-admitted interpretation of the Sacred Volume?

CHAPTER XXIII.

Effects of running water—Advances and recessions of the sea—Examples—Changes in the earth's surface by other agents—Examples—West India hurricanes—Natural hydraulic presses—Counteracting agencies—Volcanic effects—Pompeii, Herculaneum, &c.—Lava-currents of Vesuvius, Etna, and Hecla—Modern cone of Vesuvius—Asiatic volcanoes—Volcanic zone—American volcanoes—Volcanoes of the Pacific Islands—Connexion of volcanoes with water—Connexion of volcanoes and earthquakes—Volcanic motions—Elevation of the Chilian coast—Subsidences frequently caused by earthquakes—Examples—Geological inferences deduced from volcanoes and earthquakes—Etna—Val-del-Bove—False assumptions of geologists—Jorullo—Interior of volcanoes—Amount and effects of internal fires—Expansion of bodies by heat—Effects of such expansions—Rash conclusions—Mutual relation of volcanic action—New volcanoes—Periods of their formation—Ejected rocks and extinct craters—Condensed gases—Pressure and effects of gases—Earthquakes—Transmission of earthquake-effects through air and water—Lisbon earthquake—General remarks.

THE effects produced by the action of rivers, the amount of matter borne down to the ocean by running water, the various strata formed at the bottom of the sea, and the organic remains embedded in such formations, have been already noticed. There are other powerful agents in constant operation, which have produced considerable changes, both on the surface of the earth, and deep within its crust.

The ocean in one place encroaches on the land, and swallows up extensive tracts, overspreads the isthmus and converts the peninsula into an island, wears down the coast, and frequently usurps the place of the fresh-water lake. In another place it recedes from the land, and long tracts of coast are redeemed from the ocean; gulfs and salt-marshes are drained, and the island is again united with the continent. "Natural and artificial barriers have yielded to the increased pressure of the North Sea, and large tracts of the mainland are lost in its waters, while the islands along the coast, which indicate a once-continuous tract of land, have been diminished, and are still undergoing waste."

In the 13th century, the Zuyder-Zee was excavated, and in the 15th, the wide surface of Bies-Bosch was overwhelmed. Nôtre-Dame-des-Portes was a harbour in 898, though it is now a league from the shore. Psalmodi was an island in 815, and is now nearly two miles from the sea. From the nethermost point of the Gulf of Trieste to the south of Ravenna, recent accessions of land have been made of more than one hundred miles in length, and from ten to twenty in breadth. The waste of the coast of Holderness is known to cause such accumulations as to fill up many hollow places, and elevate several thousands of acres connected with the estuary of the Humber. Humboldt is of opinion that the West India Islands once formed a circuit of land about the gulf of Mexico. That England was united with France, and Ireland with Scotland, is a prevalent opinion. That America was united with Asia by the Aleutian Islands, and with Europe by Greenland, Iceland, and the Scottish Isles, is considered by some not improbable.

The submarine forests along the shores of the Orkneys and Hebrides, on different parts of the English coast, and in several other places, show extensive subsidences of land. Human industry has saved much of the low lands of North-west Europe, and of many other localities, from the dominion of the sea. The Isthmus of Suez is daily increasing in width by the accession of fresh deposits on the shores of the Mediterranean. The current along the African coast preys upon the land, and even upon the delta of the Nile, and is adding to the Syrian coast. Tyre and Sidon are now far inland. Much land is also formed along the coast of Guiana, by the oceanic current, which carries the sediment brought down by the Amazon towards that coast.

There are several facts on record to show the extent to which the surface of the earth has been changed by seemingly passive agents, and without the intervention of any of those extraordinary effects which the volcano, the earthquake, and the hurricane are wont to produce. The sites of the forests of Hercinia, Semana, Ardennes, and many others, are now occupied by fens and morasses. The axes, coins, wooden wedges, chopped trees, &c., so commonly found in Hatfield Chase, Yorkshire, and other parts of England, fix the historic date, and show the situation of these ancient forests, which are, in many instances, turf-moors at present. The site of the forest of Hatfield Chase is, in many parts, from thirty to forty feet below the present surface of the country. Under the loose hills of sand between Birmingham and Brumley, in Lincolnshire, roots of large trees, with the marks of axes, are found; a fact which shows these places, though now so altered, to have formerly been the site of extensive forests. The axes, and marks in the trees, demonstrate the work of man, and the remarkable change which a few years may effect. Had there been no proofs of man's existence, doubtless these changes would have been referred, by those who seem anxious to extend the age of this planet, to remote geological epochs.

"At the bottom of a new river or drain, almost one hundred yards wide, by four or five miles long, were found old trees, squared and cut, rails, gate-posts, bars, old links of chains, and an old axe, like a battle-axe, and two or three coins of Vespasian. But what is more remarkable, the very ground at the bottom of the river was found in some places to be in ridges and furrows, thereby showing that it had been ploughed and tilled in former days."* These facts show how much the face of a country may change in a few years, even from ordinary causes.

When we contemplate extraordinary causes, as hurricanes, mountain-torrents, earthquakes, volcanoes, &c., we are prepared to observe, without surprise, the most striking changes in the earth's crust. A West-India storm, in the words of Washington Irving, will convey an idea of the dreadful effects which hurricanes produce in countries subject to these visitations. "At mid-day a furious wind sprang up from the east, driving before it dense volumes of clouds and vapours. Encountering another tempest from the west, it appeared as if a violent conflict ensued. The clouds were rent by incessant flashes, or rather streams of lightning. At one time, they were piled up high in the sky; at another, they descended to the earth, filling the air with a baleful darkness, more impenetrable than the obscurity of midnight. Wherever the hurricane passed, whole tracts of forests were shivered, and stripped of their leaves and branches; and trees of gigantic size, which resisted the blast, were torn up by the roots, and hurled to a great distance. Groves were torn from the mountain-precipices, and vast masses of rock and earth precipitated into the valleys with terrific noise, choking the course of rivers," &c.

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* These extracts have been taken from the geological works of Lyell and Phillips, which contain many other curious facts, illustrating the singular changes which the surface of the earth has undergone.

Water, penetrating into the crevices of rocks and mountain-fissures, and communicating with subterranean lakes, frequently acts as a mechanical power of great force, and is instrumental in producing extraordinary effects. Natural hydraulic presses are thus formed in elevated grounds, which sometimes extend beneath bogs and low lands, producing effects like those to which the following lines make allusion :—

" But when the streamlet finds an open way
Through fissured rocks, or indurated clay,
To the dark subterranean lake below,
From whose smooth surface the long columns grow:
Long watery columns, which extend on high
From the closed lake, above the nether sky;
Far as the limit of the frozen lines
That mark the snow-capp'd Alps or Apennines,
And terminates the growth of Andian pines;
It generates a latent power more vast
Than ocean's wave, before the wintry blast;
Than engines raised of old to batter down
The walls of Juda's desecrated town;
Than all the force which modern art can bring
To raze the tower, or give the steam-train wing.
This press hydraulic, made by nature's hands
No valve controls, no binding force withstands,
No power resists : the mountain-mass is torn;
The rock is rent; the shattered fragments borne
Far distant, by the gushing streams which flow
Like fire from Etna, or like fields of snow,
From Blanc's high summit, on the vales below."

In every part of the material world, counteracting influences are in constant operation. Food supplies the waste of animal bodies, and these by their decomposition, give back to the mineral and vegetable kingdoms, the elementary substances that compose them. Ancient rocks are worn down, but new ones are being re-consolidated; rivers derive their supplies from the ocean, but they pour back their waters again into its bosom. The *degrading causes* which are constantly wearing down the earth, and bringing it into the depths of the sea, are counterbalanced by *elevating causes*, which are as constantly in operation, forming new islands, or rescuing new lands from the dominion of the ocean.* Air and water, by their mechanical action and decomposing properties, are the principal agents in wearing down the earth. Fire, as exhibited in the phenomena of volcanoes, must be regarded as the leading instrument in counteracting the effects of these elements.

The quantity of matter ejected by volcanoes in the different ages of the world, and the changes effected by such eruptions in the crust of the earth, must have been very considerable. The ashes, stones, &c., shot up from craters, are of the same material composition as the solidified parts of the lava. These mostly fall on the slopes of the mountain, and help to give it its conical form, and to augment its external diameter. It is supposed that greater accumulations happen in this way, on and around Etna and Vesuvius, than are produced by the flowing lava. Pompeii, Stabiæ, and Herculaneum were buried in ashes to the respective depths of sixty, eighty, and one hundred feet. Sometimes the ashes are carried to great distances by the wind. Great commotions occur during eruptions, by which heavy rains are produced, sweeping away the falling ashes in rivers of mud, which cover up cities, and fill lakes and valleys. Herculaneum is supposed to have thus perished, while Pompeii was overwhelmed with dry ashes. It is a striking feature in volcanoes, that all of them are situated near water, from which it would appear that their action is intimately connected with that element.

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* When islands are formed, or sea-coasts raised, or estuaries filled up, it must be remembered that these operations occur on the great submarine elevations, which constitute the foundations of the existing continents and great islands. These immoveable bases are unaffected by the raging of the sea; and were it possible for the waters of the ocean to wear down the present land, and engulf it in its depths, the earth would be again submerged, but the worn-down continents could only reappear upon the foundations on which they are now based, as the quantity of matter above the ocean-level, would be insufficient to fill up the tenth part of the deep abysses which the sea now occupies. But even upon these bases, they could not reappear, as the same cause which destroyed them, would be still in operation to prevent their re-formation; and hence, the idea of former continents worn down, and new ones to be constructed from the ruins of the present, are chimeras, which neither fact, nor science, nor analogy justifies.

The current of lava, emitted by Vesuvius in 1737, and which destroyed Terra-del-Greco, is supposed to have accumulated thirty-three millions of cubic feet; that of 1794, above forty-six millions. The current of Etna in 1669, which overwhelmed Catania, was estimated at ninety-four millions of cubic feet. Other eruptions of this mountain are said to have been four or five miles in breadth, fifteen in length, and from fifty to one hundred feet deep. Vast as these were, they sink into insignificance, when contrasted with that of Skaptaa-Jokul, in Iceland, in 1783. This fearful eruption formed burning lakes, some of them from twelve to fifteen miles wide, and one hundred feet deep. The lava in its course filled valleys six hundred feet in depth, dried up and occupied the place of lakes; and flowed in one direction to a distance of fifty miles, being fifteen miles in breadth; and in an opposite direction, forty miles, being in this torrent seven miles broad. In narrow defiles the depth amounted to six hundred feet.

The rise of the modern cone of Vesuvius since A.D. 79, is one of the most remarkable events which has occurred within the last twenty centuries. Stromboli is always active, but never violent. The Caucasian chain of mountains is full of volcanoes. Syria and Palestine abound in volcanic appearances, and are known to have suffered from earthquakes in early periods. The peak of Demavend, 14,000 feet high, in the Elburz range, on the south side of the Caspian Sea, is a volcano; and others exist in Arabia, Persia, in the Altai mountains, and in other parts of Asia. The Island of Sumatra contains four volcanoes, one of which is 12,000 feet high. In the Island of Java thirty-eight exist, rising to various heights, from 5,000 to 12,000 feet. In 1772, the largest fell in, and destroyed forty villages, and about 3,000 persons.

From Java the line of volcanic action passes through Sumbawa, the Banda Isles, Celebes, Moluccas, Philippine Islands, &c. Japan contains ten, and the Kurilean Islands nine, active vents. The Aleutian Islands continue the line of volcanoes to Russian America. In 1795, an island 3,000 feet high was cast up in this chain.

The peninsula of California contains three active volcanoes. Mount St. Elea is 17,875 feet above the ocean-level. In Mexico there are five active vents, viz., Justla, Orizaba, Popocatepetl, Jorullo, and Coluna. The great mountain-chain of Guatimala contains no less than twenty-one active volcanoes. South America contains a greater number than any other division of the globe. They seem as if connected through the chain of the Andes for 5,000 or 6,000 miles. Those in Quito, according to Humboldt, are portions of one great mass which occupies a space of six hundred square leagues. The volcanic parts of the West Indies appear to form a portion of this vast system.

Volcanoes abound in the Islands of the Indian and Pacific Oceans. The Ladrone Islands constitute a chain of this class. The enormous crater of Kirauca, in Hawaii, is very remarkable. "The crater was seen at a distance, in a vast plain, sunk below a precipice, which encircled the plain with a rugged border, fifteen or sixteen miles round. The crater was of a crescent shape, two miles long, one broad, and eight hundred feet deep. Lava, melted and in violent agitation, filled this singular furnace, round which fifty-one conical islands rose, twenty-two of them emitting smoke and flame, and many, great streams of lava, which rolled down to the fiery gulf below."

Volcanoes are near water, or in connexion with others that are so. Such of the American volcanoes as are far inland, are connected with others, that are supplied with water from subterranean lakes; hence, large quantities of fish are sometimes ejected during eruptions. "In the district round Hecla, the rushing water is sometimes heard in chasms beneath the surface; for here, as in Etna, rivers flow in subterranean channels through the pores and cavernous lava." The presence of water to promote volcanic action seems necessary, for it has never been disputed, that intense heat might be produced by the occasional contact of water with the metallic bases, and intense heat will produce those gases which accompany, if they are not altogether the cause of earthquakes.

Earthquakes seem to be intimately connected with volcanoes; and they occur most frequently in countries where these exist, though they are, by no means, confined to them. The motion of the earthquake is generally a premonitory symptom of the volcanic eruption. An earthquake is described as a vibration, a rolling, a shock, or an undulation; but, whatever it may be termed, its effects are generally similar, namely, a permanent elevation of the surface of the earth; though, in many instances, subsidences, and sometimes no change of elevation, have been the result. The ground is frequently rent and fissured, and numerous landslips are formed.

Many ascribe the wave-like motion of the earthquake to a corresponding motion in the internal semifluid mass of red-hot matter, which they suppose to occupy the centre of the earth; and they say, that without such an internal mass, the earthquake undulation cannot be accounted for. It would be very difficult indeed to conceive how the earth's crust, composed of solid matter, eight hundred or one thousand miles in thickness, could undulate by any internal motion in a central fluid, even granting that such really did exist. Were this crust but a tenth of this thickness, it would still be very hard to reconcile the cause and the effect. The internal fluid mass, the earth's crust, the internal wave, so far from explaining the earthquake motion, are fraught with greater difficulties than those they are intended to illustrate. Lyell says, that " the sudden fracture of solid strata might produce a vibrating jar, which, being propagated in undulations through a mass of rock several thousand feet thick, would give rise to superficial waves, even though the subjacent crust of the globe were entirely solid, and not reposing either on fluid or gaseous matter."*

We are told of an internal wave, but not how such a wave is generated. If the earthquake-wave is produced by the motion of this fluid, why not also ascribe to the same cause the shock, the vibration, and the rolling motion? But then, it should be told how these motions could be referred to a central fluid, and how transmitted through the earth's crust. But these would involve difficulties which geologists are not prepared to answer.

In 1822, the Chilian coast was agitated by an earthquake, which extended nine hundred or one thousand miles, and raised, it is said, the whole line of coast for a distance of one hundred miles; at Valparaiso, three feet, at Quintero, four feet. The beds of oysters and other shells were raised quite to the surface. The whole region between the Andes and a line far out in the sea, is supposed to have been permanently raised two or three feet. In the interior, the elevation is supposed to have reached seven feet.† An enormous wave, twenty-eight feet high, followed by another still greater, destroyed the town of Telcahuano. Columns of smoke rose in the sea, followed by whirlpools. Throughout the entire province of Conquenes and Concepcion, the crust of the earth was rent and shattered in all directions.

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* Principles of Geology, vol. ii, p. 380.

† Mr. Cuming, however, denies the effects attributed to the earthquake at Valparaiso, namely, an elevation of the coast; and he affirms, that no such phenomenon took place; and it must be admitted, that the report of its elevation is not based upon authority more credible than that upon which the denial is founded.

Earthquakes have very often caused subsidences of land. In 541, Pompeiopolis was half swallowed; in 867, Mount Acraus fell into the sea; in 1112, the city of Liege was flooded by the Meuse; in 1186, a city on the Adriatic shore sank into the sea; in 1596, the sea covered many towns in Japan; in 1638, St. Euphemia became a lake; in 1682, Port Royal is believed to have sunk; and in 1755, the Lisbon earthquake caused a new quay to subside, when its place was occupied by water one hundred fathoms deep. In 1819, large tracts of country at the mouth of the Indus sank.*

These examples are given to show the mighty power which earthquakes and volcanoes exercise, and the vast extent of their operations. A few only have been noticed, as the object is not to give a history of these phenomena, but to convey a just idea of the changes which they must have produced in the earth's crust. In them we find additional causes for changing the physical geography of the earth; but geologists wrest these phenomena, as they do the other portions of natural science, to their own purposes—earthquakes, to prove the existence of an internal, heated nucleus; and volcanic action, to mark the various eras of the earth's existence, both tending to establish the antiquity of our planet, its former supposed high state of temperature, and its origin, as from nebulous matter, or a fragment of the sun, as the early geologists imagined.

Etna has been the theatre of many geological controversies.† De Beaumont and Lyell think this mountain could not have been formed in less than 20,000 or 30,000 years. Lyell says, "We can look back to the time when the marine strata whereon the great mass of Etna rests had no existence; and that time is extremely modern in the earth's history."‡ Elsewhere he says, "There are about eighty cones on Etna, and if we conjecture the whole of them to be formed in 12,000 years, how inconsiderable an era would this be in the history of the volcano of Etna!" and again, "The oldest lavas of Etna were poured out many thousands, perhaps myriads of years before the newest."* The section formed by the great flood of 1769, called the Val-del-Bove, supplies data for geological arguments in favour of this notion. "A section of the vertical part of the mountain has been laid bare, in which the deposits are exactly similar to the modern, and none of them equal to the great lava-current which destroyed Catania. This natural section is four thousand feet high; and there are about one hundred different lava-currents to form it. Allowing one lava-current in a century, it would require for the formation of that part of the Val-del Bove, which is not more than one-third of the mountain, the period of 10,000 years;" and of course for the formation of the whole mountain 30,000 years.

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* Abridged from Phillips' Geology, vol. ii.

† See Cardinal Wiseman's 5th Lecture on Science and Revealed Religion.

‡ Vol. ii, p. 91.

It is rather unfortunate for the science of geology, that rash and ill-judged conclusions have been too frequently deduced from its facts. The case before us is but another instance of this. One lava-current is allowed in a century, and the mountain is supposed to have been formed by a series of such currents, cast upon the exterior like the successive coats of colour laid on by a painter. Both these assumptions are gratuitous; nay, they are false, and hence, the inferences deduced from them are erroneous.

If every part of Etna were volcanic, it would not follow that 30,000 years, or even a tenth part of that period, would be necessary for its formation. It must, however, be admitted that, if the mountain had been formed by showers of scoriæ, or by currents of lava poured upon its external surface once in a century, 30,000 years, or even 100,000, would be as little as we could allow for its formation. But the lovers of marvellous antiquity have grossly miscalculated, and as grossly misconceived this subject. Volcanoes are not wholly nor even principally formed by external coatings of lava, or of scoriæ.

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* Vol. iv, p. 2, 67.

They commence from within, and from within they are chiefly formed. The celebrated Humboldt tells us how Jorullo was first formed, and this, perhaps, is the only instance on record in which any special notice has been taken of the origin of volcanoes. " A tract of ground," he says, " of several square miles in area, rose up like a bladder ere a crater was made or lava ejected." If the tract so raised were sufficiently spacious to contain the internal fluid, there would be no eruption. If circumstances rendered the internal space too limited, a crater would be formed. If the nature of the up-lifted ground were such as not to admit of much elevation without giving way, an eruption would occur. The lava, in contact with the up-lifted earth, and the subsequent coatings which may line the interior of the arched dome, being subject to different rates of cooling, would exhibit different layers of lava *long before* any external current could add to the magnitude of the volcano.

Fiery masses do exist in the bowels of the earth, which never make their appearance in volcanic action, but which communicate heat to thermal springs, and produce other phenomena. Even in volcanoes which have active vents, through which they discharge their superabundant lava, several internal coatings are added to the vast arches which overhang the incandescent masses beneath, and owing to which the superincumbent mountain is for a long time prevented from falling into the cavity formed by the ejected lava. These cavities are, probably, so circumstanced, by the overhanging of their roofs, that they may resist for a long time the tendency of the superincumbent weights to fall in. The great mountain-mass of Popandayang, in Java, fell into the great cavity out of which it had been raised; and L'Altar, in Quito, lost its commanding summit by a similar fate.

Magnitude and form depend much more upon internal than upon external operations. Lyell supposes the loftiest volcanic cones to be as insignificant when contrasted with the products of fire in the nether regions, as the deposits of shallow estuaries when compared to submarine formations accumulating in the abysses of the ocean. In his remarks upon what occurred when Monte Nuovo was thrown up in 1538, he says that a chasm opened in the sea, by which vast quantities of lava in the form of scoriæ were cast into the air, and that if the melted matter in this case had been prevented from reaching the surface by the weight and tenacity of the superincumbent rocks, it might, perhaps, have heaved up a district *three times as extensive as Sicily.*[*]

How strangely geologists contradict their own favourite theories! Here it is admitted that a district, three times as great as the whole island of Sicily, might have been raised in a few days, and yet, it *must take* 30,000 years to form the cone of Etna! Surely, such a mass of lava, deep in the earth's crust, and pressed towards the surface by internal forces, could not require 30,000 minutes, much less 30,000 years, to raise the mount of Etna to its present elevation. Were the matter ejected from Hecla, in 1783, prevented from overflowing by the weight or tenacity of the superimposed strata, it would form a mountain as great as Etna or any of the American volcanoes. We are not, therefore, to reckon the age of a volcano by its magnitude, for this will depend upon the amount and violence of its internal matter; neither are we to estimate that age by its layers of scoriæ or lava, for these are often composed of matter of a different mineral character, which, in the act of cooling, must exhibit different appearances, and hence, may seem of different degrees of antiquity, though really contemporaneous.

Even though layers of earth or rock should alternate with the lava-layers, still this would not prove the cones to have been formed by scoriæ and lava, cast upon the exterior by the eruptions which had taken place. Lava is composed of melted rock, earth, metals, &c., and as these different substances, when in a state of fusion, will form into layers, by means of their different specific gravities, as happens in the smelting of certain metallic ores, it follows that one stratum of lava may be composed of matter which, being broken into fragments in cooling, and crumbling into dust or earth by exposure to the elements, would exhibit the appearance of earthy matter long before other parts of the same contemporaneous mass. And such strata, penetrated by the water which enters cavernous lava, may even contain organic remains of plants or animals, though originally produced from within, as has been already noticed; so that alternate layers of earth, where such exist, are not proofs that superincumbent layers of lava were externally laid upon them.

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[*] Principles of Geology, vol. iv, p. 4.

Experiments made by Colonel Totten, in America, show that fine-grained granite expanded with 1° Fah. at the rate of ·000004825, while crystalline marble expanded ·000005668, and red sandstone ·000009532. "Now, according to this law of expansion," says Lyell, "a mass of sandstone, a mile in thickness, whose temperature was raised to 200° Fah., would lift a superimposed layer of rock ten feet above its former level. A part of the earth's crust equally expansible, a hundred miles in thickness, raised 600° or 800°, might produce an elevation of between two and three thousand feet."* When heat, generated at considerable depths beneath the surface of the earth, becomes so great as to fuse rocks, and reduce to a state of incandescence vast portions of the earth's crust, the heated matter naturally expands; and should any part of the superimposed strata yield to the pressure from below, a mountain may be raised, and a volcano of considerable magnitude formed, in a very brief period. The lava, lifted by mechanical pressure, "rises in the tubular passage of the mountain towards its summit, and if the sides of the cone are strong enough to resist the accumulating pressure, it may even overflow the top. But, generally, the slowness with which an eruption proceeds, is such as to allow of the lava making for itself lateral passages to the surface, on the flanks of the mountain, through fissures which yield to the column above. Such lateral eruptions have raised many minor cones on the slopes of Etna, and round the base of Vesuvius."

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* Geology, vol. iv, p. 384.

But, if the quantity of lava is such as not to overflow, and if the sides are sufficiently strong to resist the weight of the column, the interior will be covered with a coating of the lava. Or, should the sides of the mountain give way to the pressure of the ascending column, the fiery mass within, in receding towards the new-made crater, will leave upon the internal arched dome, a coating of lava; and as several interior convulsions occur in volcanoes which are never exhibited externally, any section of such a mountain ought to exhibit a variety of distinct strata. The Val-del-Bove is an instance of this, and should be considered in this light, and not as geologists have supposed. But while we deny that volcanoes have been formed by external layers of scoriæ and lava, we readily grant that these have, in many instances, greatly increased the magnitude of some volcanoes, and contributed to give them their conical form.

Vast quantities of incandescent matter exist below the surface of the earth; the expansion of this matter, while becoming heated, may raise the superimposed strata, or portions of the liquid mass ascend through tubular passages. In the latter case, one large volcano, like Vesuvius or Etna, may suffice as a vent for the superabundant matter; or it may be discharged through a number of smaller craters, like the extinct cones of central France. Upon this principle, large volcanoes may cause the extinction of many smaller ones; and small ones, in a constant state of activity, may diminish in frequency and amount the eruptions of great ones. Stromboli, the light-house of the Mediterranean, may, perhaps, stand in this relation to Vesuvius or Etna. The volcanoes of Italy and those of the Grecian Archipelago mutually affect each other; a similar relation between the volcanoes of the Andes has given rise to the opinion, that one vast system of subterranean incandescent matter occupies a space of 600 square leagues of South America. We believe no eruptions of Etna and Vesuvius have ever been known to occur simultaneously. Etna reposes when Vesuvius is troubled; and Vesuvius peaceably looks on when his gigantic confrere is agitated.

Volcanic eruptions prevent the occurrence of earthquakes in countries subject to such visitations. Italy and its islands have rarely felt the shocks of earthquakes, doubtless on account of the volcanoes of these countries. The report of the sudden appearance of a volcano near Lisbon, in 1848, greatly tended to allay the terrors occasioned in that metropolis by previous shocks of an earthquake, which had thrown down some buildings, and had been felt through the whole city. These facts afford fresh proof of the intimate connexion of earthquakes and volcanoes; and show, besides, natural causes, why some volcanoes may become extinct, though in a state of activity at no very remote period.

The vast amount of lava produced by chemical agencies within the bowels of the earth, and the effects which it must produce exteriorly, afford sufficient reason to believe that the greatest volcanoes in existence might have been the work of a few days. To conclude, therefore, that Etna required myriads of years for its formation, or that it acquired its present magnitude by ejected lava, is an assumption as unjust as it is unphilosophical; and to suppose that every stratum in the Val-del-Bove required a hundred years for its formation, is a gratuitous assertion, which scarcely merits refutation. In fact, the hundred layers shown in this section of Etna, supposed by geologists to have been formed in as many centuries, might have been produced in as many years, and without the aid of one single external shower of scoriæ, or of a lava-current.

In 1538, the Monte Nuovo was thrown up in forty-eight hours to a height of 440 feet, with a circumference of 8,000 feet. In 1669, the lava from Etna was estimated at 140,000,000 cubic yards. Monte Rossi, on the slope of Etna, was formed in a few hours, in 1690. In 1759, Jorullo rose up to a height of 1695 feet, "and the bounds of this convulsion," says Humboldt, "are still distinguished from the fractured strata." The new island of Sciacca appeared in July, 1831, and disappeared the following winter. It rose near Sicily to a height of 107 feet, with a circumference of 1080 yards, out of the sea, 100 fathoms deep. A dangerous shoal, shelving gradually to the deep sea, now occupies its site. In 1638, an island in the Azores rose from 160 fathom water, in fifteen days, to a height of 360 feet above the sea. Another island was formed in the same group in 1811, one mile in circumference, and 300 feet high. In 1795, a volcanic island, of vast height and extent, was thrown up in the Aleutian chain; and islands thus raised in a few days from deep seas, may be ranked with volcanoes of the first class. And had they been formed on land, like Jorullo, or on elevated plains, like the volcanoes of the Andes, perhaps they would not be inferior in magnitude or elevation to Etna or Cotopaxi. And why not adopt these facts as the criteria for determining the age of volcanoes, rather than the hundred layers of the Val-del-Bove? They would, certainly, be more just and rational.

Stones of eight pounds weight were thrown from Vesuvius to Pompeii, a distance of six miles. During the eruption of Teneriffe, in 1798, the mountain Chahorra threw up stones to a height of from 2500 to 3600 feet. Cotopaxi is known to have hurled a rock of a hundred tons weight to a distance of more than ten English miles. Earthquakes which occurred at the eruption of Toniboro in Sumbawa, near Java, were felt over a circle of 2,000 miles in diameter, and were attended by a whirlwind of surpassing violence. When the *power* is proportioned to the *effect*, in nature as well as in mechanics, the *time* must necessarily be in the same ratio.

The great number of extinct craters, the vast space over which volcanic remains are diffused, the distance to which the active principle at present extends, and the extraordinary effects produced, leave no doubt as to the magnitude of chemical action in the extent of surface and the depth to which it penetrates.

The vast explosion of gases which accompany earthquakes and volcanoes, shows them to originate from the same principle. When gases are generated in low situations, and near volcanoes, they may escape through the craters, when clouds of ashes and other light particles are borne along by the torrent. " The experiments of Faraday and others have shown that many of the gases, including all those which are most copiously discharged from volcanoes, as carbonic, sulphuric, and muriatic acids, may be condensed into liquids by pressure, at temperatures from 30° to 60° Fah. The pressure required varies from fifteen to twenty atmospheres, and this amount is small in the operations of volcanoes. A column of Vesuvian lava, from the top of the crater to the level of the sea, would be equal to about 300 atmospheres; hence, a great store of expansive force may be packed into a small space. Such gases have the same expansive power as if fluid.—These elastic fluids are capable of producing extraordinary effects, and frequently project solid masses to immense heights. In other cases, gas may drive before it masses of liquid lava. The gas having obtained more room, may remain at rest, the lava may harden, and permanent elevation may ensue."* Large masses of lava may also be raised, and at every such movement, a new stratum of lava may be internally added to the vast domes which overhang these incandescent seas.

Earthquakes are often preceded by long droughts, and by electrical appearances in the air. The shock comes on with a rumbling noise, sometimes with a rushing noise like wind, and sometimes explosions, like the firing of cannon, are heard. Sometimes the ground heaves perpendicularly upwards, and sometimes rolls from side to side. Chasms are made, from which, water, flame, or smoke, is emitted. Sometimes the sea is divided to a great depth, and quantities of gas, smoke, or flame, are discharged. These effects are like what may be naturally expected to arise from the generation of vast quantities of gases within the bowels of the earth, and appear more in accordance with the chemical hypothesis, than with that of a central fiery nucleus.

When an earthquake occurs, the effects may be distinguished from those caused by the transmitting or conducting powers of the air, ocean, or earth's crust. The Lisbon earthquake, in 1755, cannot be said to have extended to the West Indies, or even to Italy or Scotland, though some phenomena connected with it were perceptible in these places. Dr. Arnott says that "the mercury fell so far in the barometers, even in Britain, as to disappear from that portion of the top usually left uncovered for observation." As no effect communicated through the earth or the ocean could thus affect those barometers, it is evident that the cause must be referred to the atmosphere, and probably was occasioned by the immense quantity of gas set free on that occasion. This supposition accords with the chemical hypothesis, and seems confirmed by what occurred at that time in Portugal.

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* Lyell's Geology, vol. ii, p. 383.

A subterranean noise was heard in the morning of the 1st of November, 1755; this was instantly followed by a shock, and in less than three minutes after the first sound, the greater part of Lisbon was destroyed. About 30,000 persons perished under the falling edifices. The sea retired from the harbour and left the bar dry, but soon returned in an immense wave, fifty or sixty feet above its usual level. The quay sank down into an abyss that opened under it, and thousands who retired thither, were destroyed. The mountains round the city were shaken from their foundations, and some were cleft and rent quite to their bases, and vast portions of them thrown down into the valleys, while flashes of electric fire issued from their sides. At Oporto, the earth was seen to rise and fall, violent gusts of wind were forced through the waters from chasms which opened and shut again in the bed of the river. At Cadiz, the sea rose in a wave to the height of sixty feet, and swept everything before it. One huge wave washed along the shore for a considerable distance, probably caused by the elevation or depression of a vast portion of the bed of the Atlantic, under which the focus of the earthquake seemed to lie. The effects were felt in several parts of Europe, and the sea was agitated along the coasts as far as Norway. The lakes of Durham, Cumberland, and Scotland, felt the shock.

The electric flashes which darted from the mountains near Lisbon, or the torrents of gas which issued from the earth at Oporto, were not the effects of a simple rending of the earth's crust, by the undulatory motion of an internal fluid mass. They were the effects of those chemical operations which material substances, in all stages of combination, undergo. They show the origin of earthquakes and volcanoes to be identical. They indicate one principle as the source of these frightful phenomena, and they are but additional facts to prove that no central heated nucleus could account for all the phenomena of earthquakes and volcanoes; and, consequently, that no conclusive argument in favour of such a nucleus, can be fairly deduced from these extraordinary appearances. The facts detailed above, also indicate the wonderful *effects* likely to result from the vast magnitude of the scale of *causes*. Hence, to infer that a mountain or an island which might have been produced in a few days or hours, could require myriads or millions of years for its formation, is, to say the least of it, inconsiderate and inconclusive.

Earthquakes destroy cities, throw down mountains, alter the course of rivers, and elevate portions of the ocean's bed, as well as extensive tracts of land. Volcanoes cast up islands in the midst of the sea, pour out rivers of lava, scatter ashes and scoriæ to vast distances, and accumulate seas of fire within the earth. Rivers and oceanic currents wear down, and transport to distant localities, quantities of matter, greater than can well be imagined. Air and water, by mechanical or chemical action, produce continual changes even in the hardest bodies; in short, the constitution of the earth's crust, as well as the physical appearances of its surface, are liable to so many changes from natural causes, that we can neither be surprised at any facts which geology reveals, nor at a loss for their obvious causes. But, while we admit the mighty changes which have taken place, and are still progressing in every part of the material world, we cannot be insensible to the evidences of *design* in the plan, of *wisdom* in the arrangement, of *power* in the execution, and of *divine superintendence* in the direction of every part of the visible creation. These are so well known, because so evident, in the organic kingdoms, that any notice of them here is altogether unnecessary. But it is not so with the mineral world, where, to an ordinary observer, all seems a confused mass of matter, thrown together, as it were, by chance, and without any regard to order, regularity, or design. But the case is quite otherwise: the All-wise Creator did not leave the earth's crust to be moulded by mere accident, nor the mineral world to be the sport of the elements. No; the organic kingdoms are not more wonderful than is the place designed for their reception; nor do they bear more evidence of design than that on which they absolutely depend for their existence. The creation and arrangement of animals are not less admirable manifestations of Divine Providence, than the clothing of the earth with verdure, or the filling of each part with life and motion. The latter, in our view of things, may be more striking, but all are equally the work of God, and all, alike, the act of Infinite Power.

Rocks, and soils, and every other mineral, were made together. The earth's crust was filled with veins to contain metals, and to be the conduits of electrical currents. The metals which these veins contain, were placed within the reach of man for very obvious purposes. The clayey soil was made to retain moisture, the sandy one, to allow it to pass through. The mountain-mass was raised to collect vapours, that falling rains may form rivers in descending, and so move towards the sea. Matter was endowed with such properties, that every particle seems capable of supporting, directly or remotely, some species of animal or vegetable life. Scarce a body in existence impermeable to water; and scarce a body, through which water passes, through which organic life may not also pass; and hence are found so many living creatures within the bowels of the earth. The earth-worm, in all its varieties, and the other animals which burrow in the earth, open the soil, that air and water may have more free access. Other creatures penetrate to greater depths, as the fishes of the Kentucky cavern, and those ejected by the American volcanoes, testify. Indeed, there seems no reason why different strata, as well as different zones and climates, may not have their own peculiar inhabitants. It would not interfere with the laws of animal distribution, nor be incompatible with any known principle of natural science; whilst it would help to account for the presence of some fossils, in places where it may otherwise be rather difficult to answer for their appearance.

CHAPTER XXIV.

Primary cause of the deluge—Universality of the deluge—Opposite opinions of Lyell and Buckland—Connexion between natural and supernatural causes—Examples—Scripture miracles; the Prophet's visit to king Ezechias—Retrograde motion of the shadow on the king's dial—Sun stopped by Josue—Effects which should result—Miraculous effects by natural agents—Passage of the Red Sea—The natural causes employed on this occasion—Waters of the Jordan divided by supernatural means—Examples of the concurrent action of natural and supernatural agents in producing miraculous effects—Distinction between natural effects and miracles—Examples—Natural causes employed in producing the deluge—Natural causes directed by Providence—Effects predicted by inspired persons, as indicative of God's wrath—Though produced by natural causes, yet would not occur in the ordinary course of events had man been faithful to his Creator.

It has been shown that changes in climate must result from changes in physical geography; and that elevating and degrading causes are powerful agents in effecting such modifications in the earth's crust, so as to alter materially the physical condition of several localities. There is, however, one remarkable event, the Noachian deluge, which has altered the physical constitution of the earth's crust, greater, perhaps, than the combined effects of all other known natural causes.

What has produced this deluge? whence came the water to overtop the highest mountains? All those who credit revelation, are persuaded that this scourge was sent by an offended Deity to punish the transgressions of man. This is known and believed to be the primary cause. But how far the Almighty has made use of secondary causes to produce it, is a subject upon which the same unanimity does not exist. Some deny the universality of the deluge, and would confine it to the regions which man then occupied. Others, who grant that the waters swept over the surface of the earth, will not admit the *simultaneous universality* of the deluge, and affirm, in support of this opinion, that there is not in the universe a sufficient quantity of water to submerge the highest mountains. Others, again, who believe the *simultaneous universality*, meet the objection arising from insufficiency of water, by asserting that additional water was created on that occasion, and, subsequently, annihilated, or otherwise removed from the surface of the earth by Almighty Power. We do not credit any one of these opinions. We are persuaded that the deluge was universal—simultaneously universal, and that there was neither creation nor annihilation of any portion of water; and that there existed and still does exist a sufficiency to submerge the whole earth, even the highest mountains.

There are strange things in science which may likewise be extended to other matters, and by which many subjects may be made to appear under new aspects altogether. To speak more plainly, there are propositions in science which appear absolute impossibilities to those of limited information, while to others, of more extensive acquirements, they are but simple truths, which any one possessing this degree of knowledge may easily comprehend. And these facts, also, are calculated to explain, how beings of superior intelligence can clearly conceive what, to man's limited reason, appears an insuperable difficulty. But an example will best elucidate our meaning. A person well versed in arithmetic, but ignorant of other branches of science, may affirm the square root of a surd quantity to be an *absolute impossibility*. Let us take the number 2 for instance. Now, the square root of 2 *must be* greater than 1 and less than 2; it must, consequently, be a mixed number, whose square will reproduce 2. But no such mixed number exists, because the square of any possible mixed number can never produce a whole number. There is, therefore, no number between 1 and 2, which, when squared, would make 2 ; and, therefore, the square root of 2 is not between 1 and 2, and does not, consequently, exist. This is the reasoning of the mere arithmetician, and is just enough if we confine ourselves to that department of science. But a child who knows the first book of Euclid, can solve the difficulty, and show that the diagonal of a square whose side is one, is that identical *square root* of 2, which was required. Again, we can neither trisect an angle, nor double a cube, if we confine ourselves to plane geometry, nay, everything in that department of science leads us to think these also to be absolute impossibilities, although they present no serious difficulties to those who are acquainted with the properties of the higher orders of curves. Those who think the existing amount of water insufficient to submerge the Alps or the Andes, are similarly circumstanced with the arithmetician, or the mere geometrician. They, very rationally, imagine that a volume of water covering the whole surface of the earth, and at least five miles in height, would be wanted in addition to the quantity already in existence to effect what the Scripture narrative declares to have occurred at the period of the deluge. The present quantity, say they, would not suffice, and more water must have been created. True, it would not suffice in the ordinary way to produce a universal, simultaneous submersion of the earth, but the difficulty will disappear when the subject is considered in another point of view, as shall be shown hereafter.

Dr. Buckland thinks the deluge to have been " a violent and transient rush of waters, which tore up the soil to a great depth, excavated valleys, gave rise to immense beds of shingle, and carried fragments of rock and gravel from one point to another, and, during its advance and retreat, strewed the valleys, and even the tops of many hills, with alluvium." Lyell, on the contrary, says that " there are no terms employed in the narrative of Moses that indicate the impetuous rushing of waters, either as they rose or as they retreated. The olive-branch brought back by the dove seems as clear an indication to us that the vegetation was not destroyed, as it was then to Noah that the dry land was about to appear. For my own part, I have always considered the flood, when its universality, in the strictest sense of the term, is insisted on, as a preternatural event, far beyond the reach of philosophical inquiry, whether as to the causes employed to produce it, or the effects most likely to result from it."*

The Mosaic account of the deluge is too explicit to leave any room to doubt its "universality, in the strictest sense of the term," and, though the inspired penman's narrative may not "indicate the impetuous rushing of waters," yet there is quite enough expressed to justify the opinion of Dr. Buckland; and there are also such traces of its ravages remaining yet, as are quite sufficient to prove its violence. There are known reasons to believe, that in some localities the waters rose and fell again, without any extraordinary commotion, as the olive-branch brought back by the dove, and the fact, that the ark seems to have moved no considerable distance from the place where it was built, lead us to suppose, though we cannot look upon these circumstances as conclusive evidence on these points. We cordially agree with Lyell in the opinion, that miracles are "far beyond the reach of philosophical inquiry," and that no effort of human reason can fathom those mysterious operations produced by supernatural agencies, of which the mind of man can take no cognizance.

There are cases, however, in which natural causes are so connected with supernatural events, as to seem the remote, or even the proximate agents, in these operations. In other cases, the laws of nature are suspended or reversed, and the miraculous effect is produced in opposition to those laws by which the visible creation is governed. The prophet slain by the lion,* the boys torn by the bears,† Ezechias healed by the figs,‡ the prediction of Eliseus,§ Jonas devoured by the whale,‖ and several other supernatural events, recorded in Scripture, are examples of the first class of miracles. The fall of Jericho,¶ the Brazen Serpent,** Daniel in the lion's den,†† the Hebrews in the fiery furnace,‡‡ and innumerable other miracles, are examples of the second class.

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* Principles of Geology, vol. iv, p. 219.

When the prophet visited king Ezechias, he seemed to pay no regard to the nature of the sign by which the king's recovery was to be manifested, knowing that, whether it was natural or supernatural, the result would equally be the work of Heaven. "Wilt thou," said he, "that the shadow go forward ten lines, or that it go back so many degrees?" The king, however, less indifferent to the nature of the miracle, replied, "It is an easy matter for the shadow to go forward ten lines, and I do not desire that this be done; but let it return back ten degrees."§§ Had the king consented to the first proposal, his cure would not have been the less certain, nor less the effect of the Divine interposition, though the miraculous effect would have been denoted by natural means. But having required a supernatural sign, and the shadow having actually returned ten degrees upon the dial, an event, "far beyond the reach of philosophical inquiry," took place.

If we reason on this miracle by the principles of astronomy, as understood at present, the motion of the earth upon its axis should not only have been checked, but actually reversed; and the result of this would be, either a longer day than usual, or a quicker motion of the earth upon its axis, to make up for the lost time in the retrograde movement. But no such phenomena appear to have occurred; and hence, we cannot, by any natural causes, account for this miracle.

Neither can we reconcile with our philosophy, the miracle in which "the sun stood still in the midst of heaven, and hasted not to go down the space of one day."* If the earth ceased to turn on its axis, why did not the waters of the ocean sweep over our continents, and bury them again beneath its waves? Such an effect would follow from the sudden check of the earth's diurnal motion; but no such effect then occurred. If the moon, which moved not towards the valley of Ajalon, had been stopped in its orbit round the earth, according to our philosophy, its centrifugal and centripetal forces should have ceased, and the tidal currents of the ocean should have been stayed for a day; but we are not told that such was the fact, though we are certain that the sun and moon stood still, "the Lord obeying the voice of man." How far beyond the reach of philosophical inquiry are the miracles recorded in Holy Writ, and those which are recognized by the Catholic Church!

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* 3 Kings, xiii.
† 4 Kings, ii, 24.
‡ 4 Kings, xx, 7.
§ 4 Kings, vii.
‖ Jonas, ii.
¶ Josue, vi.
** Num. xxi, 9.
†† Dan. vi.
‡‡ Dan. iii.
§§ 4 Kings, xx, 9, 10.

Although we cannot, by the light of natural reason, know how miracles are performed, or subject them to the test of inquiry, we are not forbidden to inquire how far natural agents concur, either remotely or proximately, in the execution of the Divine will. There are instances on record, in which the instruments used, seemed only exercising their natural properties, or propensities, whilst executing the judgments of God: the locusts in Egypt,† the fiery serpents in the desert,‡ the figs by which Ezechias was healed,§ are examples.

The following are still more remarkable instances in which the Almighty used natural agents in the execution of his will: "And a wind going out from the Lord, taking quails up beyond the sea, brought them, and cast them into the camp for the space of one day's journey, on every side of the camp round about, and they flew in the air, two cubits high above the ground."|| Whether this wind was produced by supernatural means, or by natural causes, is needless to examine, as, in either case, it went out from the Lord, and showed the Divine interposition manifestly displayed on the occasion. The former may appear more wonderful; though, in the latter case, the Divine superintendence, and the particular providence of God, extending to all the natural operations, and to all the phenomena of the visible creation, would have been more strikingly displayed.

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* Josue, x, 13. † Exodus, x. ‡ Num. xxi. § 4 Kings, xx, 7.
|| Num. xi, 31.

When the Egyptians pursued the Israelites, and were close upon them, "the Lord took it (the sea) away by a strong and burning wind, blowing all the night, and turned it into dry ground."* Were this strong and burning wind the *kamseen* of Egypt, or the *simoom* of Arabia, or were it a new wind, produced by the ordinary causes, its occurrence at this precise time, at the moment "when Moses had stretched forth his hand over the sea," proves the fact to have been miraculous.

In whatever manner this wind was produced, it cannot be deemed the sole agent in parting these mighty waters. A strong and burning wind might assist in dividing the waters, and in drying up the bottom of the sea, but it could not hold "the waters as a wall on their right hand and on their left," while the Israelites were passing through. And were it even possible for a mighty wind to effect all this, it would have prevented, as effectually as the sea itself, the passage of the Israelites. The waters of the Jordan were divided, when the feet of the priests, who carried the ark, entered into it;† and, subsequently, by the mantle of Elias,‡ though no wind occurred, and no natural causes were employed on those occasions. These, and innumerable other similar manifestations of supreme power, afford ample proof, that whether the threatened punishments or promised rewards of the Almighty be fulfilled by natural or supernatural causes, we must regard them as miraculous.§

If an effect be the result of natural causes, it is not miraculous; but if an event be predicted long before its accomplishment, and if natural causes be directed by the particular providence of God to that end, the result cannot be regarded as the effect of natural causes, but rather as the fulfilment of the Divine decrees, and must be regarded as miraculous. The history of Achab furnishes an appropriate example to illustrate our meaning. In battle with the Syrians, he was mortally wounded by a random arrow from a Syrian bow. This would appear to be the mere effect of chance or accident. But the prophet whom he had imprisoned, " to be fed with the bread of affliction and water of distress, till his return in peace," had said to him, " If thou return in peace, the Lord hath not spoken by me."*

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* Exodus, xiv, 21. † Josue, iii, 15. ‡ 4 Kings, ii, 14. § See Dr. Hay on Miracles, vol. i, c. vii.

From this we learn, that God had determined to punish Achab for his crimes ; and though the instruments of his death were natural agents, and all the circumstances in the ordinary course of events, yet still the death of this impious man was not less the effect of God's just indignation against him. Would Achab have thus perished had he been a just prince ? Doubtless, his fate would have been otherwise, as was that of Josaphat, who was more exposed to danger. God would have averted the arrow which deprived Achab of life, had he been worthy of such a favour. The death of the apostate emperor Julian, a cruel persecutor of the Church, is another instance. His death, in Persia, was foretold by many eminent saints ; and he fell as did the impious Achab. The destruction of Ninive was prophesied by Jonas. His preaching moved the king and people to penance. What was the result ? The anger of Heaven was appeased, the iniquities of the people were forgiven, and the city was saved from ruin. Would this have been so, had the inhabitants, like the antediluvians and Sodomites, persisted in evil ? Doubtless not. Fire from heaven would have consumed, or an earthquake would have overwhelmed, or an army of barbarians would have destroyed the city, as the prophet had foretold ; and though the agents in its destruction might have been natural, yet they would have been but instruments in the hands of God, for the chastisement of a wicked and idolatrous people.

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* 3 Kings, xxii, 28.

The deluge furnishes an analogous case. God decreed to punish man for the general depravity into which the children of Adam were fallen; Noah warned them of the impending fate; but they were deaf to his admonitions. All flesh was to perish by "the waters of a great flood." Natural agents were employed to produce it, for the narrative expressly declares that "the fountains of the great deep were broken up, and the flood-gates of heaven were opened." By these natural means the highest mountains were submerged; and, in what way soever these causes were brought into action, the effects were not the less miraculous. If the proximate causes of the deluge were produced by supernatural means, then all philosophical inquiry must cease, and the obvious meaning of the text, as to the extent and universality of the deluge, must be simply admitted. But if it can be shown that remote natural causes concurred to produce the immediate cause of the deluge, still, it must not be inferred that the result would have followed, whether or not man had sinned, whether or not "the Lord had repented him that he had made man on the earth." Such natural causes were directed by the peculiar providence of God, to a determinate end, to which they would not have arrived, or from which they would have been averted, had God been moved to mercy by the repentance of man.

The Almighty uses natural causes as listeth him. Sometimes they are reversed, as the shadow upon Achab's dial; sometimes suspended, as in the case of Daniel in the lion's den, or his companions in the Babylonian furnace; sometimes directed to particular ends, as in the destruction of the temple of Jerusalem, the reprobation of the Jews, the death of Achab, the election of David, the deluge, &c. In all these cases, the events may be regarded as miraculous, though produced by apparently natural causes. The fact, that they were predicted long before their accomplishment, shows them to be different from the ordinary effects of natural causes, which are not regarded as miraculous. When extraordinary deviations from the usual course of nature occur, such as produce plagues, famines, &c., they are sometimes regarded as miraculous, though no previous intimation had been given of such visitations, especially when no rational causes, founded on the phenomena of nature, can be assigned for their occurrence.

These remarks have been made to guard the youthful and unwary reader against the error of supposing, that results predicted by God's holy servants would have occurred in the ordinary course of things, in those cases where natural agents were employed in their accomplishment, whether or not the people had been just and obedient to the law of God; as, that the storm would have occurred at sea though Jonas had been then in Ninive, fulfilling the mission on which God had sent him; or, that the Red Sea would have been parted by the strong and burning wind, though Moses had not stretched his rod over it, or said to the people, "Fear not; stand and see the great wonders of the Lord, which he will do to-day; for the Egyptians whom you see now, you shall see no more for ever;" that quails would have been brought into the camp of the Israelites in the desert, though Moses had not promised, on the part of God, that they should be fed with flesh for a whole month, &c. Lest the arguments which we shall have to advance in proof of the universality of the deluge, should seem to favour this erroneous notion, we have deemed it necessary to make these lengthened observations, as no caution can be too great to guard against errors in doctrine.

CHAPTER XXV.

Original sphericity of the earth—Pantheism—Its absurdity—Extravagant notions of philosophers—Effects arising from the diurnal motions of planets—The earth not originally fluid—Its change of form—Causes of the change—Effects—Form and magnitude of the earth—Amount of centrifugal force at the equator—Effects of centrifugal force—The earth considered as a fluid—Amount when considered as a solid—Elevation of the equatorial sea—Countries formerly submerged—Countries formerly united—Consequences resulting from changes in physical geography—Lyell's theory of land distribution—Depression of the ocean-level—Motion of its waters—Reaction of accumulated waters—Submersion of land at the period of the deluge—Effects of lava-seas—Basin of the St. Lawrence—Polar seas—Observed facts—Probable elevation of sea-bottoms, &c.

THE original sphericity of the earth was maintained by many eminent philosophers, among whom we may mention Des Cartes, Burnet, Woodward, Whiston, &c. We will not, however, avail ourselves of the arguments made use of in support of this opinion, by those who insist upon the original fluidity of the earth, or of its formation by the accumulation of pre-existing nebulous matter about some imaginary nucleus. Such chimeras are not sustainable by facts or rational arguments; and, how favourable soever such opinions may be to the establishment of infidel theories,* we do not think that even infidels should discredit their own doctrines by such absurdities.

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* From a modern work, entitled *Vestiges of Creation*, we quote the following passage: "Space is infinite,—has not, cannot have either beginning or end. Space was originally filled with a universal *fire-mist*, or one vast, illimitable cloud, as it were, possessing a property of heat. In this cloud, at different places, were certain points (nuclei) or centres, where the fire-mist was characterized by a greater condensation than elsewhere. These nuclei consequently possessed a superior attractive force; and, by means of that force, consolidated, or absorbed into spheres or globes, the gaseous matter around them. By this power of gravitation, the nuclei would go on collecting the neighbouring matter, until masses, more or less solid, would be detached from the rest. But how came they to pass to a rotatory motion?

Sir Isaac Newton, among the rest, believed in the earth's original sphericity. In his controversy with Cassini and the French philosophers, he maintained the spheroidal figure of the earth to be that which a globe, revolving on its axis, *had a tendency* to assume, and that the present form of the earth was the natural result of its diurnal motion; and, upon this principle, he established its oblate spheroidal form. Subsequent experiments, by the vibrations of pendulums in different latitudes, and actual admeasurements in different countries, confirmed this truth.

It is well known that when fluid matter collects towards, or meets in, a centre, it establishes a rotatory motion. Matter cannot remain inactive; motion is its principle, nature is nowhere inactive; decomposition and regeneration are the effects of that universal and eternal motion. When once the nuclei had arrived at that stage, when they were nebulous bodies, the rotation on their axes commenced."

Perhaps there were never so many absurdities expressed in so few words. *Fire-mist*, or *star-dust*, or whatever it may be called, even though such matter existed, could not possibly occupy infinite space, for no created substance or material body could be infinite. Hence, every conclusion deduced from such false premises, must be erroneous.

Either the nuclei were formed at some point in time, or they had existed as long as the supposed illimitable cloud. If they existed from eternity, then the bodies which they formed should have been from eternity; for we can assign no period, however great, at which they might not have been formed. If they were formed from the cloud at any period of time, then a previous eternity had passed away ere such effects were produced; and to suppose an eternity necessary to produce an effect, involves in itself an absurdity, as no alteration in matter, which required an eternity to produce it, could ever be produced at all. If neither the cloud nor the nuclei were from eternity, they must have been created, and if created, they could neither fill *infinite* space, nor be *illimitable.*

Again, if this fire-mist existed from eternity, light and heat should have existed from eternity; and if the heavenly bodies were formed from materials possessing light and heat, all the heavenly bodies should be sources of light and heat. But such is not the case. The planets are opaque bodies, which shine, not by their own, but by borrowed light. Why are they not luminous bodies as well as the sun and stars, if, according to the notions of materialists, they owe their origin to the same cause?

A gravitating power is allowed to matter; but whence could mere matter derive a power of which the most learned philosopher is really ignorant? We know this power exists, because we perceive its effects, but what it is, how it acts, how produced, we know not. Motion is

The other planets which are known to revolve quickly on their axes, are also flattened at their poles. Jupiter is more so than the earth, as it ought to be from its quicker diurnal motion; while the moon, which revolves very slowly on her axis, exhibits no such appearance. It is, therefore, quite natural to imagine the earth originally spherical, and its present form the result of its greater centrifugal force at the equator.

Lyell shows, "that the statical figure of the terrestrial spheroid may have been the result of gradual and even existing causes, and not of a primitive, universal, and

not a principle of matter, *(See Woods' Mechanics, &c.)*, for matter can neither give motion to itself, nor check that motion when communicated to it. The rotatory motion supposed to have been produced by the collection of the fluid matter in one centre, is directly contrary to every scientific principle. The asserters of such opinions must have erred through design or the grossest ignorance.

If currents of wind, or water, or fluid matter of any kind, meet, a rotatory motion may be produced; but there are cases in which no such occurrence can take place. If fluid currents arrive at a focus from two or more opposite points, while *all* the other points from which currents could also come, are left vacant, or offer no resistance, a rotatory motion may ensue; but if currents come from every point, as fire-mist approaching a nucleus, no motion in the nucleus could be the result; for every force, calculated to produce such a motion, would be counteracted by another equal and opposite one, and, consequently, no rotatory motion could possibly be produced.

It is, therefore, absurd to attempt accounting for the diurnal motion of the planets by such a theory; but if one absurdity can be greater than another, that greater one would appear in any attempt to account for the orbicular motions of the planets by this hypothesis; for two or more distinct and different forces must concur to produce any curvilinear motion, as the centrifugal and centripetal motions must result from causes entirely different.

To follow the impious doctrines of pantheists and naturalists through all their errors, would be to little purpose, for their absurdities are more evident than the most acute reasoning can be convincing. They reject mysteries in religion, but admit them in their own doctrines; nay, they would give perfections to mere matter, which they would not concede to the Creator. But there are no opinions, however absurd, which some philosophers have not defended. Some maintain the eternity of matter, others deny its existence altogether, even some have doubted their own existence; but these absurdities owe their origin to the vain and foolish idea, that they established the character of learned men, by arguing against reason and common sense, and defending the erroneous opinions of others. Philosophy, as well as geology, has suffered more from the advocacy of vain philosophers, than from the opposition of its greatest enemies.

simultaneous fluidity."* Had the earth been originally fluid, there would be no doubt of its spheroidal form being assumed when its diurnal motion commenced. But if the earth at its creation was not fluid, it might have retained its spherical form, notwithstanding its diurnal motion, for many years subsequently. In this case, its change of form might have been gradual or sudden, or it might have extended to the entire mass of the earth, or have been limited to the external crust solely. As there are no positive proofs, nor even any founded on scientific truths, nor supported by rational arguments, to show that the earth was at any period in a fluid state, it naturally follows, that its change of form must have been long subsequent to its creation.

As it has been shown in the foregoing pages, that there are no rational proofs of the earth's existence longer than the period assigned by the Mosaic narrative, it may be very fairly inferred, that the change of the earth's form occurred at the time of the Noachian deluge, and that this event was the chief *natural cause* by which the Almighty's threatened chastisement was inflicted on rebellious man. It was sudden and universal, because man persisted in his iniquity. It might have been but gradual and partial, perhaps averted altogether, had man been faithful to the law of his Creator. There are many geological facts to confirm this opinion.

" The masses of mixed sedimentary and igneous origin, which can be shown to have accumulated since the sea was peopled with the greater number of the aquatic species now living, and which have been raised two thousand or three thousand feet above the sea, prove an extraordinary modification in the state of the earth's crust at some unknown depth, beneath the tract so upheaved."† These facts also prove the changes in the earth's crust to have occurred at no very remote epoch, as the fossils belong to the species which now people the sea, even according to the notions of those who advocate the fond theory of successive creations. The epoch to which these events must be referred, can be no other than that of the Noachian deluge, as we shall shortly see.

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* Principles of Geology, vol. ii, p. 354.

† Lyell's Geology, vol. iv, p. 14.

The vast amount of volcanic action, which the great craters of Europe, Asia, and America exhibit, demonstrates the vast amount of incandescent matter accumulated within the bowels of the earth. And, surely, the chemical operations by which such seas of lava could have been generated, must affect the earth's crust to a great depth.

The rotation of the earth on its axis communicates to these liquid masses a tendency to move towards the equator. The effect of centrifugal force on the heterogeneous matter within the earth, combined with the greater downward pressure of bodies, in the direction of the polar axis, also gives to the whole mass a similar tendency, which has probably produced an elevation of the equatorial regions. As the action of the elements continues to undermine a building long before its fall, so internal operations might have continued for centuries, to dispose matters for the wonderful phenomenon which the Almighty decreed to be the agent in changing the form of the earth, and producing the deluge, which was to sweep man, and all flesh, from its surface. The chemical effects produced by the contact of water with the metallic bases, formed a remote preparation for this awful disaster.

The transition of the earth from the spherical to the spheroidal form, would produce the deluge, and afford a natural cause, sufficient to account for all geological phenomena. Extinct volcanoes and other volcanic remains may be particularly specified. The internal lava, pressed forward towards the equator by the centrifugal force, would, in many instances, burst the frail crust which enclosed it, and form partial volcanoes, which might continue in a state of activity until the internal pressure ceased, either by the discharge of the superabundant matter, or the permanent elevation of the superimposed strata.

When a lava-sea exists within the earth, a pressure of strata upon one part of it, will cause an elevation of some other portion of the fluid. In some cases such elevations of the fluid may produce volcanoes. Should the pressure be withdrawn, or another vent be opened, the former volcano may become extinct; and several have become extinct by such means. Should former craters have been choked or blocked up by the effects of the deluge, and thus rendered incapable of acting as tubular passages for the escape of the enclosed lava, a new one may open elsewhere, and the former become extinct.

It is certain, that no necessity exists for supposing "a primitive, universal, and simultaneous fluidity," in order to account for the earth's change of form; sufficient causes have been in existence to produce that effect. If many such oceans of lava as Hecla cast forth in 1783, had existed before the deluge, their united agency, combined with other causes, and all directed by an overruling Providence to one end, would be quite enough to alter the figure of the earth, and produce, or greatly tend to produce, that universal catastrophe, in which the antediluvian world was overwhelmed. A series of natural causes seemed to concur in producing the ruin of the city and temple of Jerusalem; a different series of natural causes may also concur in producing the deluge; and yet, both may be no less the effects of God's judgments, than if fire from heaven, or a destroying angel, had been made the instrument of divine vengeance.

"There shall be great earthquakes in divers places, and pestilences, and famines," which may be brought about by natural causes, accompanied by "terrors from heaven,"* as signs to precede the day of judgment. In like manner might the deluge have been, in great part, produced by natural means.

The earth is an oblate spheroid, or a figure formed by the revolution of an ellipsis on its conjugate diameter. A meridional section of the earth would exhibit this ellipsis. The greater or equatorial diameter is 7925·648 miles; the polar diameter or axis of revolution, 7899·170 miles. The difference of these diameters, or the polar compression, is 26·478 miles. These diameters are to each other, very nearly, in the ratio of 299 to 298, and their difference is $\frac{1}{299}$ of the greater, or very little more than $\frac{1}{300}$ of the equatorial diameter.

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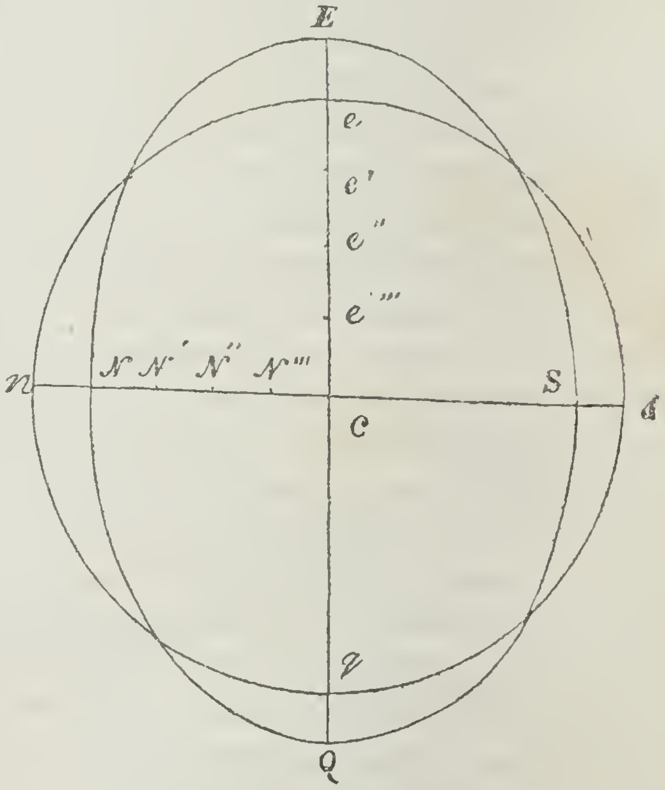
* Luke, xxi, 11.

The diurnal motion of the earth produces a centrifugal force, which, at the equator, appears to be $\frac{1}{289}$ part of the force by which all bodies tend towards the earth; that is, $\frac{1}{289}$ of their weight. The sea, at the equator, is, consequently, lightened by this fraction of its weight, and may, therefore, be supported at a higher level. Had the earth been a fluid mass, or composed of homogeneous matter, $\frac{1}{289}$ would be the fraction expressing the difference of gravity at the equator and poles, arising from the centrifugal force. But experiments made with the utmost care and precaution, give the general result at $\frac{1}{194}$; that is, 194 lbs. at the equator, would weigh 195 lbs. at the poles. The difference of these fractions, which is $\frac{1}{590}$, is found to arise from the figure of the earth, for similar bodies, placed at the pole and equator, stand in different relations to the whole mass of the earth; and, without any reference to centrifugal force, their weights are different. This difference amounts to nearly $\frac{1}{590}$ part, which, with the $\frac{1}{289}$, arising from the diurnal motion, makes up the $\frac{1}{194}$ part; which corresponds with the most approved experiments.

Had the earth been a sphere, the attraction of bodies any where placed on its surface would be precisely the same. Were the earth created spherical, and of such a nature as to resist, for some time, the tendency produced by its diurnal motion, to assume the spheroidal form, the centrifugal force, at the equator, would be such as to lessen the weight of bodies by $\frac{1}{289}$ part; that is, 289 lbs. at the equator, would weigh 290lbs at the poles, and the sea would be lightened at the equator in this proportion. But though the centrifugal force at the equator is increased by the ellipticity of the earth, "this very ellipticity of form modifies its power of attraction on bodies placed at its surface, and lightens still more the weight of bodies at the equator by nearly $\frac{1}{590}$ part of their weight."

Were the earth a fluid mass of uniform density, a column of the fluid, extending from the centre to the equator, would be exactly counterpoised by another similar column from the centre to the pole. Now, if two such columns be divided into the same number of equal parts, each portion of the equatorial column will be something longer than the corresponding division of the polar column ; and each division of the equatorial column will be proportionably lengthened by the action of the centrifugal force, according to its distance from the centre. In that division nearest the surface, in which all the other increments are included, the elevation of the equator will be shown. This elevation will not be the result of the centrifugal force upon the external division alone, but in that division *all the effect* produced upon the whole mass will be exhibited.

To render this more intelligible, let the ellipsis N E S Q represent a meridional section of the earth in its present form ; and the circle n e s q, a similar meridional section of the earth, considered as a globe. E e, Q q will represent the equatorial elevation ; N n, S s, the polar depression. Let C N represent the polar column, E C the equatorial one, CN‴, N‴ N″, N″N′, &c., the divisions of the one, and C e,‴ e‴ e″, e″ c′, &c., the corresponding parts of the other. Each portion of the equatorial column lengthens as it approximates the surface, on account of its greater velocity, and, consequently,



its greater centrifugal force. The increments in each succeeding portion are all included in Ee. Now, if we suppose the earth to have been at first a perfect sphere, and capable of resisting for some time the effort of the centrifugal force to change its form, the effect of this force will be only visible in the waters of the ocean, which would flow towards the equator, there accumulate, and form one vast sea.* The elevation of the sea would be inconsiderable compared with the present elevation of the equatorial regions, but quite sufficient to produce the most striking change in the physical condition of the whole surface of the earth.

It would be very difficult, perhaps impossible, to estimate the exact amount of this elevation, on account of the inequality of the depth of the sea, the position of land, and various other causes. It may, however, be closely approximated. At present, the equator stands thirteen miles higher than the poles, and the centrifugal force maintains the existing ocean, as it were, on an inclined plane, thirteen miles high and 6,250 miles in length. Hence, the centrifugal force is sufficient to change a fluid sphere into a spheroid, whose revolving axis is twenty-six miles longer than its fixed axis. Let us suppose a fluid globe, 8,000 miles in diameter, revolving on its axis with such velocity as to elevate the equatorial regions thirteen miles, a column of the fluid, from the centre to the equator, would be thirteen miles longer than a similar column, from the centre to the poles.

Let us again suppose these columns to be divided into 1000 parts, of nearly four miles each; the external division may represent the depth of the sea, as probably the general depth of the great oceans average about four miles. If the increment in the first division of the equatorial column, produced by the centrifugal force, be represented by x, that of the second division from the centre will be $2\ x$, for the radius being double the former, the circumference described in the same time will be double; the motion will, consequently, be double, and a double force will produce a double effect. For the same reason, the increased length of the third division will be $3x$, and so on to the surface, where the increased length of the external division will be $1000x$. These will form an arithmetical progression, viz., $x + 2x + 3x \dots 1000x$, whose sum is thirteen miles;* hence, $1001x \times 500 =$ 13 miles, and $x = \cdot 1371$ feet, and $1000x = 137 \cdot 1$ feet; that is, the increased length of the outer division, produced by centrifugal force, will be nearly 138 feet. If the depth of the great ocean be three miles, this external division would be 103½ feet; and if the general depth were only two miles, still, the external division of the column would be very great: it would be sixty-nine feet. As this external division is intended to represent the ocean, the inference must be, that, had the earth been fluid, a depth near the surface, equal to that of the existing sea, would, by the centrifugal force, be increased in the above proportion. Now, as the land and sea are at their highest elevation in the middle regions of the earth, the water, in reference to the adjacent countries, is different from what it would have been had the earth been spherical, and so constituted as to resist the tendency of the centrifugal force to change its form, as we suppose it to have been before the deluge. Then the sea, only, felt the influence of the centrifugal force, and was precisely as much affected as the external division of the supposed equatorial fluid column. But that division was shown to amount to 137 feet when the radius of the earth was divided into 1000 equal parts; hence, the equatorial sea, previous to the deluge, would have been more or less elevated above the adjacent land in proportion to its depth. Had it been but two miles deep, it would have been sixty-nine feet above its present level; if three miles deep, 103½ feet; and if four miles, 137 feet.

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* See Newton's Principia, vol. ii, p. 187.

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* The sum of this progression is justly assumed at thirteen miles; for, though a sphere in becoming a spheroid, by rotation or otherwise, would not be so much elevated above its former level; yet, if additional fluid be conceived to be supplied, so that no polar depression take place, the equatorial elevation will fully amount to this. But as polar depression and equatorial elevation must necessarily occur in the change of the earth's form, it may be well to remark, that in such cases, the depression is double the elevation. Let $R =$ the radius of the globe, and $p = \cdot 5236$. Then will the solidity of the sphere be $8R^3 \times p$. Let $x =$ the elevation E e, (see figure), and $y =$ the depression N n. Then the major axis $QE = 2R + 2x$, and the minor axis $NS = 2R - 2y$; hence, $(2R + 2x)^2 \times (2R - 2y) \times p =$ solidity of the spheroid. But as the solidity of the sphere and spheroid must be equal, $8R^3 \times p = (2R + 2x)^2 \times (2R - 2y) \times p$, rejecting the common multiplier p, $8R^3 = (2R + 2x)^2 \times (2R - 2y) = 8R^3 + 16R^2x + 8Rx^2 - 8R^2y - 16Ry - 8x^2y$, cancelling $8R^3$ at both sides, and rejecting the small quantities which do not contain R^2, we get $16R^2x = 8R^2y$, and dividing by $8R^2$, we have $2x = y$, that is, twice the elevation equal to the depression. Hence, if the earth were to change its form from that of a sphere to an oblate spheroid, the equatorial region would have been raised but 4⅓ miles above its former level, while the polar region would have sunk 8⅔ miles, causing a difference of 13 miles between the pole and equator.

As the equatorial regions are supposed to have been elevated about 4⅓ miles above their former level, it is natural to conclude that extraordinary changes in physical geography then took place. Much of the African and Arabian deserts, of the low lands within the tropics, were sea-bottoms; while great tracts towards the poles, now occupied by deep seas, were either dry land, or covered with much shallower water than at present. Several modern men of science are of opinion that the Sahara is the site of an ancient sea, and that " an immense sea once occupied the south of Europe, and extended from the Atlantic to Asia, and comprehended the south of France, Spain, Sicily, part of Italy, Dalmatia, part of Syria, &c." Rennel affirms that " the sea once washed the base of the rock on which the pyramids of Memphis stand, the present base of which is washed by the inundation of the Nile, at an elevation of 70 or 80 feet above the level of the Mediterranean."

Perhaps no geological inference is better supported than this theory is by the following fact, which furnishes direct evidence of the former state of Egypt and northern Africa. " Proceeding from Cairo in a south-east direction, the traveller passes for five miles along a valley, through which a river-torrent appeared to have flowed, skirted on both sides by low, brown, rocky ridges. He then turns suddenly off to the right, and beyond the first range of sandhills, finds, spreading as far as the eye can reach, a vast expanse of rolling hillocks, covered with prostrate trees. At first sight these wear exactly the aspect of rotten wood dug out from a Scotch or Irish peat-bog; the colour and amount of decay seem the same. They are lying in all positions and directions on the surface of the burning sand, some forty or fifty feet in length, and one or two feet in thickness, not continuous or entire, but in a line broken across, left in their places like sawn trunks. On touching them, instead of proving mouldering and decayed, they turn out to be hard, and sharp as flint; they ring like cast iron, strike fire with steel, and scratch glass. The sap-vessels and medullary rays, the very bark and marks of worms and insects, and even the spiral vessels, remain entire; the minutest fibres of the vegetable structure are discernible by the microscope. The trees are scattered loosely, and at intervals, over the desert, all the way from Cairo to Suez, a distance of eighty-six miles."* As these trees " lie upon the surface of bare drift-sand and gravel, reposing on limestone-rocks of the most recent tertiary formation," their silicification must have occurred within the *recent* period, as " the texture and colour of the imbedded oyster-shells seem as fresh and pure as if brought not six weeks from the sea."

These facts, and the many other indications of extensive submersion which northern Africa and southern Asia present in many places, afford proofs, not " that the whole desert is manifestly one of the most recent of our upheavals," but that previous to the deluge it was the bottom of an extensive ocean, and that the vast sea or lake in which these forests were petrified, was subsequently converted into an arid waste by the revolutions which occurred in the physical geography of this district, not in the remote eras of geologists, but within the period assigned by the inspired writer to the existence of our planet.

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* Papers lately laid before the Literary and Philosophical Association of St. Andrew's, by Dr. Buist, of Bombay.—*Edinburgh Journal.*

Tasso also alludes to this circumstance:—

> " First marched the forces drawn from Egypt's lands.
> Four were their chiefs, and each a troop commands.
> Two came from Upper, two from Lower Nile,
> Where ocean's waters once o'erspread the soil;
> Now lie far distant from the briny flood,
> Those fields which once the coasting sailor viewed."

Others imagine the Old and New Worlds to have been formerly united; at one side, by Greenland, Iceland, Scottish Isles, &c., and on the other, by the Aleutian chain of islands. There are many circumstances which make it probable that England was once united with France, Ireland with Scotland, and many of the northern European islands with the continent. That vast tracts of land existed in the southern hemisphere before the deluge, is a far more rational conjecture than even the existence of a southern continent at present, notwithstanding the recent explorations and discoveries in that region of the globe. " The prize essay given by a society at Amiens, in 1753, on the subject whether England had been formerly united with France, was gained by Desmarest, then a young man. His arguments in favour of the union were founded on the identity of the composition of the cliffs—on a submarine chain—on the identity of the noxious animals, &c."

It may be objected to this hypothesis, that we indulge too much in speculation; but let it be remembered, that this speculation is founded on well-authenticated facts, and on scientific truths. And if geologists claim the right of speculating on what *may* and what *might*[*] have occurred in past times, why may not we also claim some indulgence in that way, especially as we found our speculations, not on vague conjectures, but on admitted truths.

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[*] " They felt themselves" (the early geologists), says Lyell, " at liberty to indulge their imagination at what might be, rather than *inquiring what is.*" The following passage from book iv, p. 364, is one of the many instances in which Lyell indulges his own imagination in guessing "at what *might be*, rather than inquiring what is." "We may suppose," he says, " a vast submarine region, such as the bed of the western Atlantic, to receive for ages the turbid waters of several great rivers like the Amazon, Orinoco, or Mississippi, each draining a considerable extent. The sediment thus introduced *might* be spread over an immense area by the action of a powerful current like the gulf-stream. In another part of the same ocean *let us suppose* masses of

The great equatorial sea, which, in the case we suppose, would have occupied the vast deserts of the South, and extended, with very little interruption round the globe, would have considerably modified the distribution of heat on the surface of the earth, and produced corresponding changes in climate and temperature. The trade winds, which are principally caused by the rarified air of the African and Arabian deserts, would have been particularly affected. The greater amount of evaporation from the torrid zone, and the consequent humidity of climates in general; the extraordinary change in the physical geography of the earth, and, perhaps, the general decrease of temperature,* might have rendered Siberia a fit habita-

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coralline and shelly limestone to grow like those of the Pacific over a space of several thousand miles in length, and 30° or 40° of latitude in breadth, while volcanic eruptions give rise to igneous rocks, &c. It is evident that during such a state of a certain quarter of the globe, limestone and other rocks *might be* formed, and retain a common character over spaces equal to a large portion of Europe." If this mode of accounting for the formation of secondary strata be admissible, surely the theories of the early geologists are entitled to some consideration; for it is fully as difficult to have seas and mighty rivers at hand to form strata, as to have comets in readiness to strike off fragments from the sun, or to produce the deluge by their aqueous tails. With such early and such late geological theories to account for the phenomena of nature, our hypothesis to account for the deluge cannot be deemed extravagant by modern philosophers.

* Lyell supposed a great equatorial sea and polar continents to be the "position of land and sea which might produce the extreme of cold of which the earth's surface is susceptible." And, on the contrary, that equatorial continents and polar seas would be that "position of land and sea which might give rise to the extreme of heat." In the first case he concludes, that "not only land as extensive as our existing continents, but immense tracts of sea in the frigid and temperate zones, might present a solid surface covered with snow, and reflecting the sun's rays for the greater part of the year;—that within the tropics, the sky would no longer be serene and clear, as in the present era, but masses of floating clouds would cause quick condensation of vapour, so that fogs and clouds would deprive the vertical rays of the sun of half their power. The whole planet would, therefore, receive annually a smaller proportion of the solar influence, and the external crust would part, by radiation, with some of the heat which had been accumulated in it during a different state of its surface."

tion for those animals whose relics are so widely scattered through the low lands and along the river-banks of this inhospitable region. One certain result would, in this case, have existed, that the districts inhabited by terrestrial animals would have more nearly approximated each other in temperature than they do at present, and the constitution of animals would have been gradually inured to the change.

Had the Almighty, in order to produce the deluge, so ordained, that by means of the centrifugal force, the earth, from being spherical, assumed the spheroidal form, the following effects would naturally result. The whole equatorial region being raised, and the polar tracts proportionably depressed, the ocean could no longer remain, with respect to the surrounding land, at that height which it had maintained while the earth was spherical, and, con-

In the second case he supposes, that "if there were no arctic lands to chill the atmosphere and freeze the sea, and if the loftiest chains were near the line, it seems reasonable to imagine that the highest mountains might be clothed with a rich vegetation to their summits, and nearly all signs of frost would disappear from the earth. When the absorption of the solar rays was in no region impeded, even in winter, by a coat of snow, the mean heat of the earth's crust would augment to considerable depths, and springs would be warmer in all latitudes. The waters of lakes and rivers would be much hotter in winter, and would be never chilled in summer by melted snow and ice. A remarkable uniformity of climate would prevail amid the archipelagos of the temperate and polar oceans, when the tepid waters of equatorial currents would freely circulate. The general humidity of the atmosphere would far exceed that of the present period; for increased heat would promote evaporation in all parts of the globe. The winds would be first heated in their passage over the tropical plains, and would there gather moisture from the surface of the deep, till charged with the vapour, they arrived at the extreme northern and southern regions, and then encountering a cooler atmosphere, discharged their burden in warm rain."—Vol. i, p. 7.

These numerous assumptions are liable to many objections. The land in the arctic region is far greater than in the antarctic, and yet the temperature is higher by at least 10° Fah. Humboldt supposes a much greater difference of temperature to exist between both hemispheres. This is directly contrary to what may be inferred from Lyell's hypothesis. Captain Cook was of opinion that the ice of the southern, predominated greatly over that of the northern zones. In Sandwich Land, in 59° S. lat., the line of perpetual snow descends to the level of the sea, and in the Island of Georgia, 54° S., the snow sequently, in seeking its proper level, it would flow with great violence from the central to the polar regions. But, in consequence of the unequal velocities with which places in different latitudes are carried round by the diurnal motion of the earth, a body moving with a uniform motion from the equator to the poles, or from the poles to the equator, cannot remain upon the same meridian, and hence, the cold air of the north, moving towards the equator, to occupy the place of the rarefied air which has ascended to the upper regions of the atmosphere, actually becomes a north-east wind; and south-east winds in the southern hemisphere, are produced by similar causes. Currents moving from the equator to the poles, arrive at each point in their onward progress with velocities greater than that of the earth at these points;* consequently, the

reaches the beach, while in Scotland, in 58° N. lat. the summits of the highest mountains do not attain the limits of perpetual snow.

Ice from the south comes nearer the equator by 10° than the ice of the north, and this fact demonstrates, that ice may be found in the sea, and that polar seas may contain it as abundantly as polar land. Water being a bad conductor of heat, will receive it more slowly than land; but it will also part with it more slowly. An equatorial continent would radiate by night more of the heat it had received, than an equatorial ocean; while a polar sea could not possess a higher temperature than a polar continent, as in both cases the line of perpetual congelation would be at the level of the sea. There is no reason to suppose that mountains on an equatorial continent could be clothed with verdure to their summits, as many mountains now on the *line* are covered with perpetual snow. Nor can we suppose that a heated continent, exposed to the direct rays of the sun, would afford circumstances more favourable to humidity, than those which now exist. It is far more probable, that vast tracts of equatorial land would present arid wastes like the Sahara, than fertile plains like those of the temperate regions.

As the heat of the sun is always a constant quantity, and its diffusion over the surface of the earth subject to so many modifying causes, it is difficult to say what arrangement in the physical constitution of the earth's surface would produce the extremes of heat and cold. We do not deem it important to discuss this point at present, as our object is to show that a subsidence at the poles, and a corresponding elevation at the equator, would afford a natural cause for modifying the climates of the earth, and probably be instrumental in producing the universal, simultaneous submersion of the whole earth.

* A current from the equator to the north acquires the velocity of the earth on its axis at any point, and partly retains this velocity in

earth is actually left behind by the fluid, and hence, such currents become south-west in the northern, and north-west in the southern hemisphere.

The waters of the Pacific Ocean, therefore, in flowing towards the north, would be driven against the west coast of North America; the north branch of the Atlantic against the western coasts of Europe and Africa, and the other oceans against the corresponding coasts of the other continents. The existing continents becoming thus the barriers against which the oceans were impelled, would have been totally submerged by the accumulating waters. The currents from the Atlantic and Pacific Oceans, penned up between the continents, and pressed by the flow of waters from the wide expanses behind, would sweep about the north pole, and accumulate, so as to overtop every barrier; and rushing again from the north over the adjoining continents, would unite in many instances with other torrents, produced by the rain of forty days and forty nights, and be thus fully adequate to submerge the highest mountains.

The waters of the southern hemisphere would likewise circulate round the south pole, there accumulate, and, by the reaction of such masses of fluid, would return again towards the equator; and thus might the earth have been submerged simultaneously, without any new creation of water, and without derogating in the slightest degree from the miraculous power by which secondary causes were made instrumental in punishing man's delinquency.

The Scripture narrative evidently refers to some extraordinary commotion in the sea, where it says, that " all the fountains of the great deep were broken up." The opening of the flood-gates of heaven is sufficiently accounted for by the rain of forty days, but without supposing some violent disturbance of the ocean, we cannot conceive what the breaking-up of the fountains of the great deep can mean. The abundant lava which probably

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passing to the next point; but, as the velocity in the more northern point is slower, the earth is, as it were, left behind, and the motion of the current must be towards the east, and it must be a south-west current.

concurred in producing this extraordinary change in the earth's form, might also be instrumental in augmenting the rain at this period; for the number of volcanoes and volcanic islands cast up in this convulsion, in contact with water, must have generated considerable volumes of steam, which, by condensation, must have greatly increased the amount of rain. Indeed, there is reason to think that many of the great volcanoes of the Old and New Worlds, as well as some vast mountain-chains, were produced on this occasion. Were the Andes or Himalayas raised at this time, how different must have been the physical constitution of these regions before the deluge from what they are now; and, in truth, we cannot suppose the elevation of the equatorial regions to have produced the deluge, without also admitting that vast mountain-masses were upheaved in the convulsion.

The singular fact, that the highest and most remarkable mountain-ranges occur towards the middle regions of the earth, strengthens the probability of this idea. But it must not be imagined that the whole surface of the earth would have been deranged by this change of form: no; the position of countries, the beds of oceans, seas, or lakes, or the course or basins of rivers, would not have been altered. "The whole hydrographical basin of the St. Lawrence," says Lyell, "might be upraised during these convulsions, yet, that river might continue, even after so extraordinary a revolution, to drain the same elevated region, and convey its waters in the same direction to the Atlantic."*

We have said, that had the earth been spherical before the deluge, and of such a nature as to resist the effort of the centrifugal force to change its form, a vast equatorial sea would have existed, which, in respect to the surrounding countries, would have been far above the level of the present sea. Had the earth's form been then changed to its present shape, the ocean should adapt itself to the new form of the earth, and, consequently, could not hold the same position respecting the adjacent lands. A great body of water would thus have to descend from the middle regions of the earth towards the poles, upon an inclined plane, sloping about one foot in every 480 feet, and thus would mighty torrents have been formed. Were the diurnal motion of the earth to cease at present, the water of the middle zone would flow towards the north and south; two vast polar seas would be formed, and the torrid zone would then become one arid continent. The centrifugal force produced by the diurnal motion maintains the equilibrium of the ocean on this inclined plane; but as this force is limited in amount, it could not keep the surplus water which occupied the torrid zone before the deluge, in its former position. The vast volume, thus rendered free to move, would be driven, by the diurnal motion of the earth combined with the motion of the waters, north and south against the coasts of the existing continents, and by the impelling power from behind, would sweep over them with all the impetuosity of the deluge.

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* Geology, vol. iv, p. 178.

It will assist us to conceive the velocity of water moving on a plane which slopes about one foot in four hundred and eighty, when we learn, that a river whose bed slopes three inches in a mile, or one foot in 21,120 feet, moves at the rate of three miles an hour.* The rush of water, in the first instance, from the Atlantic and Pacific Oceans, from the south-west, over the land of the northern hemisphere, and its subsequent return towards the south, from the north-east, would leave all these traces of its ravages which modern writers describe as yet existing on the northern slopes of the Alps, the Apennines, and the other great mountain-chains of the old continent.†

In the general elevation of the equatorial land and sea, the resistance opposed to the elevating power being generally less where the ocean was deepest, the bed of the sea was upraised, and the sea itself rendered shallower. A far greater rush of waters towards the poles than could result from the surplus water already alluded to, was produced, and these vast volumes of water sweeping over our continents, together with the rain of forty days and forty nights, would undoubtedly have submerged the most elevated regions of the earth; and the deluge might be simultaneously universal, without the creation of new water, without the violation of any scientific principle, and without deviating from the plain and simple meaning of the narrative which records this awful catastrophe.

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* Arnott's Physics.

† Cardinal Wiseman's Sixth Lecture on Science and Revealed Religion, vol. i, p. 32.

CHAPTER XXVI.

Early condition of the earth—State of geological knowledge—Physical effects of the deluge—Spheroidal form of the earth—Density of the earth—Different theories contrasted—Unwarranted inductions of geologists—Original matter—Properties of matter—Range of human knowledge—Mysteries of nature—Human reason—Mysteries of nature and religion contrasted—True philosophy—Object of creation—Opinions of Buckland and Tucker—Man—Glory of the Creator displayed in the visible world—Immensity of creation—Concluding remarks.

It would be rash and unwise to travel by unknown and dangerous by-ways, when a safe, open path lies before us. In like manner, it is reprehensible and foolish to adopt crude and undigested theories, when well-authenticated facts, and principles based upon religion and science, afford results more satisfactory. Recent discoveries have flung open the flood-gates of speculation; and theories without number have been devised to meet the difficulties which present themselves. Philosophers have considered these discoveries in every point of view; and, in almost every instance, a new hypothesis has been fashioned, if not to *explain* the difficulty, at least to suit the fancy of the theorist.

The former existence of the earth as a wandering meteor, as a fragment of the sun, as nebulous matter, as an aggregate of material particles, accumulating for unlimited ages, are the philosophical theories of its origin. Universal fluidity by heat, an existing central fiery nucleus, countless years of existence, the destruction and reformation of continents, &c., are theories invented to explain the various forms of stratification. Submersion of continents, changes in the ocean-bed, successive and distinct creations of organic life, are deemed necessary hypotheses to account for fossils. The gradual refrigeration of the earth's crust, extraordinary convulsions, &c., have been introduced to account for rents and fissures in strata, and for slips or dislocations in mineral veins; while strange alterations in the physical condition of the visible world are supposed necessary to explain the imaginary changes of climate which, geologists say, have occurred in the frigid and temperate regions of the earth. In a word, though every new hypothesis subverts some older one, still, every new discovery is sure to be ushered in by some peculiar theory; and such is the state of this science at present, that we can hear no new lecturer on geology who has not some novelty to introduce.

There are no phenomena which may not be accounted for by those causes to which we have already referred. Oceanic currents, in constant operation for thousands of years; mighty rivers, sweeping to the sea the vast quantities of matter which composed the beds in which they flow at present; earthquakes, shaking the earth, and shattering its external crust in innumerable places; volcanoes, upheaving islands, nay, groups of islands, forming huge mountains in a few days, or even hours, and discharging rivers of lava and showers of scoriæ; hurricanes, levelling forests, destroying the works of man, and spreading devastation in their progress;—these, with a multitude of other causes, co-operate in producing numberless changes in every portion of the visible world.

And should these not suffice, we have facts, and science, and experiments, to demonstrate the spheroidal figure of the earth; we have science and analogy to prove this form to have been assumed, and that the cause which produced it, is known; we have reason and common sense; we have the testimonies of philosophers, and we have Scripture authority to show, that this earth was never in a state of universal fluidity by heat; hence, we are justified in concluding, that a change of the earth's form has occurred some time after its creation. This change of form, the causes which produced it, and the consequent results, have been noticed. Should any geological phenomena exist, which come not under the widely-extended operations constantly going on, the effects of the deluge, and the convulsions which produced it, are fully adequate to account for such phenomena, and to satisfy every geologist whom fact or argument can influence.

If geological discoveries require us to admit, that mountain-masses were thrust up through previously-formed strata, we can feel no difficulty in making that admission, when, perhaps, half the earth's surface was elevated several miles, and a corresponding subsidence of an equal extent occurred at the same time. In one place, mountains, or even mountain-chains, might have been upheaved; in another place, such might disappear in the general subsidence; numerous volcanoes might then have been formed by pressure on the lava-seas beneath, in their efforts to move forward when impelled by centrifugal force. The central cones of France, and the extinct volcanoes and volcanic remains of other countries, might owe their origin and existence to this cause.

The numerous rents and fissures in strata, the clefts and chasms in rock and mountain, the dikes and veins in mines and quarries, may well be referred to this great cause, should any other be deemed insufficient to produce them.

Should rocks of organic origin occur amidst other strata, the fact may be referred to the period of the deluge, with much more reason than to those vague and visionary geological eras and events, of whose existence no proof can be adduced.*

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* It is no proof of the igneous origin of plutonic rocks, that they

The derangement of strata, the different level at which portions of the same fissure-beds of rocks are sometimes found to exist, the displacements, dislocations, &c., &c., so frequently occurring in mining districts, can, with every appearance of truth and reason, be referred to this cause.

We do not affirm absolutely, nor with proofs amounting to demonstration, that the elevation of the equatorial, and depression of the polar regions, did actually take place at the period of the deluge, or that this catastrophe was produced by such means, though circumstances make it highly probable that such was the case; our great object is to show the *possibility* of a universal and simultaneous submersion of the whole earth by natural means, without the creation of additional water. Divine power might have done all this by means "far beyond the reach of philosophical inquiry;" but in showing the possibility of effecting all this by natural means, we only give additional reasons to support the principle maintained throughout this work, namely, that there have been no successive creations of material beings. Had water been created at the deluge, and subsequently annihilated, or otherwise removed, it would afford some argument to those who advocate the distinct creations of organic beings. They may, perhaps, with some degree of reason, assert, that if *matter* was created to submerge the earth, organic bodies may also, with equal propriety, be created, if circumstances required such an exertion of creative power. We cannot, however, admit that there has been a second creation of either organic bodies, or of any material substance.

The earth, as a whole, is about five times the density of water, as known to us. Had there been a globe of water

pass, by a series of gradations, into the volcanic; for, a passage may be also traced from them to the aqueous rocks. Nor is it a proof of their igneous origin, that they contain no organic remains; for extensive masses of rock, which geologists refer to the Neptunian family, are also devoid of such remains. Masses of strata in contact with lava, would evidently be indurated; but as lava, according to the chemical hypothesis, must have been formed after the earth was made perfect in all its parts, it follows, that the granitic series of rocks owe not their origin to lava, as Lyell would have us believe.

equal in magnitude to the earth, portions of such a mass would have been compressed to a far greater extent than any pressure that can be produced by artificial means. Still, the density of the earth is "greater than if the whole were water;"* consequently, much of its interior must be far heavier than granite, other portions may be much lighter, but, *en masse*, the average would not equal half the specific gravity of lead or silver. Had the earth been fluid, its density would far exceed its present amount;† and hence, being solid, it could not assume the spheroidal form immediately after its creation. There is reason, therefore, to suppose that this change of form took place at the time of the deluge, and if so, we can be at no loss for natural causes to account for every geological phenomenon.

The facts in support of this view are undeniable, and the principles on which the hypothesis is based, are purely scientific. The conclusions are not opposed to Scripture, reason, science, nor to the general opinion of the Christians of all ages; and hence, these conclusions must be admitted by all who make not idle speculations the bases of their theories. Our arguments in favour of the literal meaning of Scripture are based upon science and the existing phenomena of nature. We could not, for a moment, imagine that fire, or water, or star-dust, or any such agents, could have produced the vast frame of creation. We have shown that fire and water have been powerful instruments in modifying the structure and properties of matter; but we could not suppose them to have generated all existing bodies. These elements have acted upon previously-existing substances, and effected considerable alterations in some of them. Geologists, not distinguishing between the formations and the originals, have erroneously ascribed to these elements, results which they have not accomplished. Water has made deposits from worn-down materials; and these deposits have been subsequently indurated by heat, or by combination with other substances, or by the action of the elements; this has led to the extended induction, that all indurated or stony substances of a certain class, have been similarly formed; whereas, no such induction should have been in justice made. Volcanic rocks are the evident production of fire: here, again, geologists extend their inferences, and trace a connexion between lava or volcanic rocks and granite, and then conclude, that granite also was produced by fire from pre-existing matter; whereas, in reality, the granitic series of rocks were formed so at first by the Creator. It is true, that many geologists do not pretend to trace matter to its origin, but merely to account for its present state in bodies as they now exist, without any reference to the condition of matter previous to its being subjected to the operations of those causes by which they suppose the present bodies to have been produced.

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* Newton's Principia, book iii, prop. 10, p. 180.

† Were the earth liquid by heat at any former period, the external part would evidently have been the lightest, and its surface would consist of matter like the lava of volcanoes. Metals would have sunk in the fluid, and be very far from the surface. In smelting ores, such is the case; the metal sinks in the fused mass, and is thus separated from the *slag*, or lava. Had the whole earth been in a similar state of fluidity, we can perceive no reason why similar results should not ensue; why the heaviest bodies would not be lowest, and the central parts, though fluid by heat, yet so dense by the pressure of the incumbent matter, as to exceed, by many degrees, the heaviest bodies with which we are acquainted. If, as Dr. Arnott states, (Physics, vol. i, p. 262), water at the depth of 1,000 fathoms, loses a twentieth of its bulk, and is, consequently, increased a twentieth in weight and density, what shall we say of the compression of fluid matter at the depth of several miles? At the centre it would, doubtless, be far heavier than gold or platinum, but with only this density at centre, and lava or melted rock at the surface, the average density of the earth, as a whole, would be considerably more than five times that of water, a circumstance which proves the earth not to have been fluid by heat at any former period.

But, although they do not, like infidels and pantheists, ascribe the origin of the earth to fire-mist, or nebulous matter, or to fragments of other bodies supposed to have been formed of this imaginary matter;* yet, the "indefinite lapse of ages" which they deem necessary for the completion of certain *effects;* and the indefinite lapse of ages which should have passed away in the production of those *causes* from which such effects have flowed; and the indefinite round of such causes and effects which they must admit who adopt these theories, without ever referring to the act of creation, or to the condition of matter in coming from the hands of the Creator, leave on the minds of the young an impression that *matter is eternal.* This impression would be, that it is *increated,* for no created matter could have been from eternity; that the properties of matter by which so many strange effects are wrought in bodies, are inherent qualities; and that the vague word, *nature,* will account for all those singular effects which, truly, must be referred to the creative power alone.

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* This supposed matter appears, by Lord Rosse's telescope, to be assemblages of fixed stars, which could only be distinguished *en masse* by former telescopes; and hence originated the idea of fire-mist, star-dust, &c.

We pretend to investigate the secrets of nature, and to account for all her operations, whilst, in reality, we are ignorant of the manner in which the least and most ordinary of her works are produced. Every object is a mystery, which we cannot fathom. A grain of sand, or a blade of grass, is quite sufficient to puzzle the most learned philosopher. Who can tell *how* inorganic matter is moulded into animal and vegetable substances? How vegetables germinate, grow, live, &c.? How animal food operates through every distinct part of the body, and supplies all its waste? How matter crystallizes? How it attracts? How all the curious combinations take place which chemistry reveals? How decompositions occur? How solids become liquids, and liquids solids, and how a thousand other wonders daily happen?

If, then, we are ignorant of how matter exists, is altered in its qualities, changes its forms, combines with other matter, &c., how can we explain a far greater difficulty, namely, how it came into existence? No created intellect can account for this, otherwise than by the fiat of God, the act of creation. Philosophy can never afford any other solution; and the more philosophers have attempted to explain, the more have they involved the subject in doubts and difficulties.

But how can these doubts and difficulties be obviated? Simply by attributing the origin, as well as the properties, of matter, to the creative power of the Almighty. The true philosopher neither seeks nor desires the further investigation of a question which the mind of an archangel cannot fathom. This submission, this bowing down of the intellect to the Supreme Being, who wills to limit the range of our knowledge, even of material things, is, indeed, *right reason.* It is the noblest exercise of this faculty. It is using reason in the most perfect manner, because it is perfectly reasonable to believe that a limited reason cannot possibly comprehend *Infinite Reason, Infinite Wisdom, Infinite Power,* by which all things have been created, directed, and governed. Whilst, on the other hand, only a reason, clouded by pride, passion, or prejudice, could persuade itself, or attempt to persuade others, that all the secrets of nature should be subject to it, and that no difficulty should exist which it could not unravel. This vain worm of the earth would say, that no mysteries should be believed which it could not comprehend; that the works of the Most High should be all within its grasp; that finite as it is, it should circumscribe Infinity; that its limited nature should be illimitable in its comprehension; and that Omnipotence should not effect more than the lowest creature in the scale of intellectual existence should understand.

These pseudo-philosophers attempt to account for all things, and yet, material things contain difficulties which they cannot fathom. The various transformations which matter undergoes in its different states, are mysteries inaccessible to human reason.—Nay, man is a mystery to himself. He is conscious of his own existence, and he feels that he has received that existence without his own concurrence. He is equally sensible of his utter inability to preserve it. A dependent being, subject to circumstances which he can neither govern nor control; yet, in his free will, he is, in some measure, an independent being. Living, and he knows not how; still, unable to continue or preserve that life to which he is so attached, or maintain that being of whose privileges he is so jealous.

Human reason, left to its own guidance, plunges into the depths of folly. Uncontrolled by faith, it is a brilliant meteor, which conducts its followers into all the mazes of error; but, enlightened by religion, it is man's noblest faculty, his highest prerogative, which raises him infinitely above all other terrestrial creatures. But how seldom are the designs of the bountiful Giver of this sublime gift fulfilled in its use and application! How seldom are those ends accomplished for which this gift has been bestowed! But, alas! how frequently is it perverted to the worst of purposes!

Thousands of objects around us, even ordinary objects, exhibit as many mysteries. We are actually ignorant of the thing we call substance; *how*, many substances exist in some bodies in a solid state, and become gaseous when separated from them, we know not. We can judge of the external qualities of substances, but of themselves we know nothing. The decay and regeneration of organic beings are likewise inexplicable, and the vital principles which animate them are not within our sphere of knowledge. We know not how spirit and matter are united, even in our own persons. We cannot explain how the meanest vegetable is produced. We can analyze, and decompose, and discover the elementary substances of bodies; but with these self-same elements at our command, we cannot reproduce the simplest portion of the lowest organic body; a fact which proves, that in the combinations of the uncompounded substances, the laws of nature operate effects, with which the most learned philosophers, or the most experienced chemists, are wholly unacquainted.

And yet, such is the folly of man, as to presume to a knowledge of all things. In his vain attempts to explain certain phenomena, he assumes data which actually require more proof than the propositions which he intends to demonstrate. His premises are frequently involved in greater difficulties than the subjects proposed to be elucidated. To account for the existence of igneous or vitrified substances, which could have been produced by chemical action, according to the existing laws of nature, the earth, forsooth, must be supposed to have been, at some former period, a red hot globe of fire; and to reduce it from that state to its present condition, a series of theories, no less extravagant, have been devised. Seas of fire and oceans of water, seemed ready at the whim of every philosopher, to assist him in framing dissolving views,—theories calculated only to deceive himself and others. Instead of referring to the creative power of the Most High God, those inexplicable phenomena, which are so abundant in nature, they have *fire-mist* and *star-dust* to mystify reason, oceans of fire and water, to drown, as it were, the misgivings which common sense suggests; and indefinite ages, to veil in mystery what neither the truths of science, nor the laws of nature, can illustrate.

Pascal justly says, "No men are so credulous as unbelievers; they will believe the miracles of Vespasian, in order to disbelieve those of Moses." If, in the opinion of infidels, it is weakness to credit the mysteries of religion, is it not folly in the extreme to adopt the unfounded theories of modern philosophers? To fancy those millions of distinct minerals, so beautiful in appearance, so varied in external qualities, so different in their inherent properties, and so evidently the work of design, could have been produced from the heterogeneous matter which water may hold in solution or in suspension, or which fire may fuse into one undistinguished mass, is a species of credulity which appertains not to the true philosopher or the sensible man. It is vain to argue that heated masses cooled down under different circumstances, and that deposits were made from water under influences widely different. Such assumptions are entitled to no consideration. Minerals so different in their properties, could not have been produced from a liquid mass of heated matter, nor from a sea impregnated with mineral substances. Lead-mines are numerous in the granitic rocks; and if both were fluid together, why did not the lead, from its greater specific gravity, sink beneath the granite and melt into one mass? Or if fluid at different periods, how came the subsequent union?

To imagine this world, so perfect in all its parts, which forms so beautiful a system, in which no want nor superfluity exists, which admits of no increase, no diminution, without injury to the whole; in whose production, Infinite Wisdom and Infinite Power are so admirably displayed, to have been the effect of chance, or to have been moulded according to the notions of modern geologists, is not in accordance with reason or religion.

Philosophers glory in discovering the properties of bodies, and in investigating the laws of nature; but the contemplation of the Author of nature would have been a far more noble ambition. Man, the lord and master of the visible creation, should not limit his study to mere material objects; he should soar higher—he should pass from the study of nature, to that of the Divine Being by whom all things subsist. The study of nature forms a useful and an agreeable occupation; but the study which leads to the knowledge and love of God, is a higher and holier employment. How impious, then, not only to omit this heavenly study, but to rob the Creator of the glory which He should derive from His works; and to refer these works, not to Him, but to a series of imaginary events, of whose existence we know little!

To imagine the mineral world could have been produced from seas of fire and oceans of water, and arranged in that order, and exhibited in that almost endless variety in which it now exists, would be a more singular coincidence of circumstances, than if all that occurred at the passage of the Red Sea had been produced by a series of natural causes. No dispassionate, rational being will believe that the elements concurred in opening the sea for one people, and closing it again upon another; of rescuing every individual of Israel, while not a single Egyptian escaped; so, no rational being will admit that any combination of ordinary occurrences, unless directed by the peculiar Providence of God, could effect those ends in which such striking evidences of design are so clearly displayed. To suppose, therefore, that the conflict of fire and water, or any similar war of elements, or, in fine, any results arising from mere natural events, could produce such scenes of order and beauty as the earth displays in its physical constitution, in its geographical relations, in its vegetable and mineral productions, and in its peculiar adaptation to the wants of its inhabitants, is, indeed, to suppose what never could have occurred. Infinite Goodness and Mercy, united with Infinite Power and Wisdom, alone could have produced this stupendous frame of creation, this admirable system, in which order, beauty, and perfection, are displayed.

We have not, however, the most remote idea of denying the influences of second causes on the mineral treasures of the earth, or the nature and properties of the soils which compose its external rind. Second causes operate extensively in the other kingdoms of creation. Plants and animals flourish not without their proper nourishment; and this is the result of second causes. Deprived of air, or heat, or moisture, they decay and perish; but still, how far are they from owing their existence to such causes! The orders, families, genera, &c., of organic beings, owe their origin and existence to creative power solely; nay, every individual, of each variety, in these two kingdoms, owes its existence to the self-same cause; nor could the simple elements, even in the lapse of endless ages, produce the lowest being of either kingdom. A wide distinction must be made between the effects of second causes, and the original production of the systems in which these causes are designed to take a part. Without the original system, produced by creative power, what we call second causes would be as incapable of producing organic beings, as steam to produce manufactured goods without an engine, without machinery, and without the aid of man; and so it is with the mineral creation;—rocks, earths, ores, precious stones, and minerals of all descriptions, were at first created, and these have been subjected to the operations of second causes. In some places, rocks are worn down and become soils; in other places, earths are hardened into stone. Crystallization, electricity, and other phenomena, are constantly effecting certain operations; and the elements are ever actively employed in wearing down, remodelling, and altering matter in various ways; and thus the mineral, as well as the animal and the vegetable kingdoms, is affected by second causes; though, in its origin, in its arrangements, and in its varieties, it is, equally with the other, the peculiar work of the Creator, and designed for the same end, namely, " man's use and benefit."

We cannot close this subject without adverting to the intentions which the Creator had in producing the visible world. " I would," says Dr. Buckland, " in this as in all other cases, be unwilling to press the theory of relation to the human race, so far as to contend that all the great geological phenomena we have been considering, were conducted solely and exclusively with a view to the benefit of man. We may rather count the advantages he derives from them as *incidental and residuary consequences*, which, although they may not have formed the exclusive object of creation, were all foreseen and comprehended in the plans of the great Architect of that globe, which in his appointed time, was destined to become the scene of human habitation. With respect to the animal kingdom, we acknowledge, with gratitude, that among the higher classes there is a certain number of living species, which are indispensable to the supply of human food and raiment, and to the aid of man in his various labours and occupations; and that these are endowed with dispositions and faculties which adapt them, in a peculiar degree, for domestication; but their number bears an extremely small proportion to the total amount of existing species; and with regard to the lower classes of animals, there are but very few among the almost countless multitudes, that minister either to the wants or to the luxuries of the human race. Even could it be proved that all existing species are serviceable to man, no such inference could be drawn with respect to those numerous extinct animals which geology shows to have ceased to live, long before our race appeared upon earth. It is surely more consistent with sound philosophy and with all the information that is vouchsafed to us respecting the attributes of the Deity, to consider each animal as having been created for its own sake, to receive its portion of that enjoyment which the universal Parent is pleased to impart to each creature that has life; and, secondly, to bear its share in the maintenance of the general system of co-ordinate relations, whereby all families of living beings are reciprocally subservient to the use and benefit of one another. In this view only can we include their relation to man, forming as he does, but a small, though the most noble and excellent part of that vast system of universal life with which it hath pleased the Creator to animate the surface of the globe."

"It is true," says Tucker, "that by applying ourselves to the study of nature, we daily find more and more uses in things that at first appeared useless. But some things are of such a kind as not to admit of being applied to the benefit of man, and others too noble for us to claim the sole use of them. Man has no farther concern with this earth than a few fathoms under his feet; was, then, the whole solid globe made only for a foundation to support the slender shell he treads upon? Do the magnetic effluvia course incessantly over land and sea, only to turn here and there a mariner's compass? Are those immense bodies, the fixed stars, hung up for nothing but to twinkle in our eyes by night, or to find employment for a few astronomers? Surely, he must have an overweening conceit of man's importance, who can imagine this stupendous frame of the universe made for him alone. Nevertheless, we may so far acknowledge all things made for man, as that his uses are regarded conjointly with those of other creatures, and that he has an interest in everything reaching his notice, and contributing either to the support of his body, the improvement or entertainment of his mind. The satellites that turn the night of Jupiter into day, assist him in ascertaining the longitude, and measuring the velocity of light; the mighty sun, that like a giant holds the planets and comets in their orbits, enlightens him with its splendour, and cherishes him with its warmth; the distant stars, whose attraction probably confines other planets within their orbits, direct his course over the boundless sea and the inhospitable desert."*

To one who only contemplates the physical powers of man, his temporary residence here, his wants, his comforts, or even his luxuries, these remarks will appear just and rational, and we may add, conclusive. But he who considers the *end* for which man was created; the ultimate *object* of the Creator in producing the "stupendous frame of the universe," and who he is that has given existence to this material world, cannot view them in this light, nor coincide in all that is expressed in the above quotations. The sun was not created *merely* to keep the planets in their orbits; nor the fixed stars to find employment for a few astronomers; nor the satellites of Jupiter to enable us to determine the longitude, or measure the progressive motion of light; nor animals to receive their portion of that enjoyment which the universal Parent is pleased to impart to each creature; nor man to waste his life in a barren examination of the works of nature. All these are indeed but "incidental and residuary consequences," but by no means the ultimate objects for which they received existence. To create them for such low, such unimportant ends, would be unworthy the Great Creator. This world, and all that it contains, were made to "show forth the glory of God;"* to display to intelligent beings, his power, and wisdom, and goodness; and for man's use and benefit. Such motives are worthy the display of omnipotent power, and all others are subservient to these.

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* Tucker's Light of Nature, b. iii, c. ix, p. 9.

In every system of art, many parts exist, which, to the untutored eye, seem to contribute little to the welfare of the whole, but yet, if that little were wanting, the system would have been imperfect, perhaps altogether useless. It is so in the work of creation—the All-wise Architect had to provide a dwelling-place for man, the noblest work of the visible creation, alone capable of knowing and of loving his bountiful Benefactor. He had also to exhibit to the higher orders of intelligence who surround his throne, this mark of his unlimited power, and this proof of his love for man, whose nature he was one day to assume. Could he be content to provide a habitation merely sufficient to supply man's necessities? Could the

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* Psalm xviii, v. 2.

Omnipotent Creator adopt the contracted notions of a modern utilitarian, and not rather display his power, wisdom, and goodness, on so important an occasion? Accordingly, he created for this end, the earth, with all its geological phenomena and external beauty; the sea, with its countless inhabitants and physical wonders; and the heavens, with innumerable spheres and planetary systems, scattered in such profusion through space, as to demonstrate that their creation cost him nothing.

The liberality of a prince is not to be estimated by the wishes or wants of his favourite, but by the generosity and magnificence of the donor. The wonderful works of nature are too much for man to claim, but not for the Almighty to bestow. "The eye hath not seen, nor the ear heard, nor has the heart of man conceived what God has prepared for those who love him" and serve him here; and shall this universe, with all its glories, be deemed too great for so bountiful a Creator to confer on those for whom he has prepared such favours hereafter. The number and magnitude of the heavenly bodies astonish us; and hence, some modest souls would deem it "an overweening conceit of man's importance" to imagine they could have been made for him. But as well might it be deemed an overweening conceit of man's importance to imagine the ocean or the atmosphere, the earth which bears him up, the animals which minister to his wants, the flowers of the field, or the most trivial things in nature, were made for him; for it must be remembered, that the same act of omnipotence which produced the smallest grain of sand or blade of grass, could with equal facility produce a sun, a planetary system, or a new creation. The same act of omnipotence was exercised in the creation of the most minute, as well as of the most glorious objects in existence.

"Let him inquire," says Pascal, "into the smallest things he knows; that a fly, for instance, should have legs with joints, veins in those legs, blood in those veins, humours in that blood, drops in those humours, and vapours in those drops. He will judge, perhaps, that this is the smallest portion of nature; but within this I will show him a new abyss; I will describe to him not only the visible universe, but farther, all that he can conceive of the immensity of nature, within the circumference of this imperceptible atom. Let him lose himself in these wonders, which are as surprising by their minuteness, as others by their magnitude." But what are those wonders so surprising by their magnitude! The same celebrated individual tells us, "Man's imagination will sooner cease to conceive, than nature to furnish matter for conception. All that we see in the world is but an imperceptible circumstance in the ample bosom of nature. No idea can come up to the extent of its spaces. We may enlarge our conceptions as much as we please; we shall bring forth nothing but atoms in comparison with the reality of things. It is an infinite sphere, whose centre lies in every part, and circumference nowhere. It is one of the greatest sensible characters of God's omnipotence, that our imagination is lost in this thought."*

If the most minute, as well as the most magnificent objects in creation, equally display the omnipotence of the Almighty; if it is as easy for him to strew the heavens with suns as the sea-shore with pebbles, or cover the fields with verdure, why should it be deemed an overweening conceit of man's importance to imagine that heaven, as well as the earth, was created for him, or on his account? Is it not, rather, acknowledging with gratitude the goodness and bounty of the Creator, to suppose all these things formed for man, than any vain conceit of man's importance, who must be aware that no merits of his could have entitled him to such distinguished marks of his Creator's munificence? The consideration of God's goodness and bounty, and of his own unworthiness, should prove a stimulus to love, rather than a motive to vanity.

Were the creation made but to supply the wants of man, how miserable would have been the visible world compared with what it is at present! how imperfect the system of nature! and how unworthy the dignity and power of the Almighty! But as the glory of God was involved, it became necessary that the universe should contain much which neither the immediate wants nor even the luxuries of man could require. None, then, but the Almighty Creator himself, or the almost measureless minds of the angelic hosts, can even comprehend the vast system of the universe, or the necessary dependence of the whole on each part. He, then, indeed, must have a vain conceit of his own importance, who pretends to determine how far each portion of creation contributes to the end for which the whole received existence. Man is the lord of the creation; he alone among visible beings is capable of admiring the works of God, and of rendering him due praise; and yet, a philosopher exclaims, "Was, then, the whole solid globe made only for a foundation to support the slender shell he treads upon?" We wonder how else could this slender shell, these few fathoms with which man has some concern, have been supported without the solid foundation which this utilitarian, this parsimonious economist, looks upon as a useless waste of matter! Every creature may enjoy its portion of that bliss which existence confers; but that all concur, more or less remotely, to the one great end for which they were called into being, is consistent with reason and religion.

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* Pensées de Pascal, c. xxii.

Hence, we count not as "incidental and residuary consequences" the advantages which man derives from creatures; they are, in fact, but fulfilling the main end for which they received existence, some remotely, others proximately. Whoever considers the admirable construction of the human frame, the wonderful union of soul and body, the sublime end for which man has been created, and the ineffable dispensations of Divine Providence in the work of his redemption and sanctification, will not think it much that a solid mass of matter supports the shell on which he treads; that the earth's varied productions minister to his wants; that stars without number adorn the heavens for his sake; and that all the phenomena of the material world should contribute towards his temporal happiness. Man, formed to the image and likeness of God, is the noblest work of this lower creation. He stands pre-eminent among the works of God, and may even emulate the sanctity of angelic spirits. On the other hand, he may, by sin, be debased beneath the level of the lowliest creature. By the violation of God's law by pride, the neglect of religious duties, or the abuse of the gifts bestowed on him by his Creator, he sinks to a miserable condition indeed. The highest order of talent is sometimes found in men devoid of religion, and even of an ordinary share of common sense. Perverting the gifts with which they have been endowed, and full of intellectual pride, they, by their sophistries, lead captive to error the young, the ignorant, and the incautious, and seek, by every device, to impugn religion and the authenticity of the Sacred Writings, which bear so manifestly the divine impress. Religion checks not rational inquiry, nor restrains the most profound research into all the secrets of nature. Being based on truth, religion has nothing to fear from what science can unfold. The Catholic Church has always been the most liberal promoter and patron of the arts, of science, and of literature.

In the pursuit of knowledge, the enlightened Christian is diffident of his own lights; he keeps in view the abyss of sin and ignorance into which man has fallen from his original state of innocence and intelligence; he guards against those delusive aspirations which caused the expulsion of the angels from Heaven, and man from Paradise. He looks forward with cheering hope to that eventful day when the materials of this cumbrous and degenerate earth shall be renewed; when "a new heaven and a new earth shall arise; when God will dwell with his people, and wipe away the tears from their eyes; and death shall be no more; nor mourning, nor sighs, nor sorrows be any longer." The pious aspirant makes all things here below subserve his glorious final destination, thus seeking beyond the grave, beyond that gloomy horizon of life, a cloudless, sorrowless world, the destined dwelling of the virtuous.

THE END.

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A GLOSSARY

OF THE

GEOLOGICAL AND SCIENTIFIC TERMS

INTRODUCED INTO THIS WORK.

A.

ABSOLUTE MOTION. Actual motion.

ACARIDÆ. A family of parasitic insects.

ADAMANTINE SPAR. A precious stone.

ALABASTER. A variety of soft marble.

ALGÆ. An *order* of cryptogamic plants. All sea-weeds are comprehended under this division.

ALKALI. Any substance which, when mingled with acid, produces fermentation.

ALLUVIAL. The adjective of Alluvium.

ALLUVIUM. Earth, sand, &c., carried by water and deposited.

AMORPHOUS. Bodies devoid of regular form.

AMIANTHUS. A species of asbestos.

AMPHIBIA. That class of animals which can live in two elements.

ANAPLOTHERIUM. An extinct quadruped of the order Pachydermata.

ANTENNÆ. The articulated horns of insects.

ANTHRACITE. A species of coal.

ARCA. A species of marine shell-fish.

ARENACEOUS. Sandy.

ARGILLACEOUS. Clayey; composed of clay.

ARMADILLO. A quadruped of South America, covered with hard bony scales.

ARSENIC. A poisonous mineral substance.

ARTESIAN WELLS. Deep wells, so named from Artois, where first used.

ASBESTOS. A sort of fossil stone, which may be split into threads. Cloths made of this substance resist the effects of fire.

ASPHALTUM. A bituminous stone.

ASTRONOMY. The science that teaches the knowledge of the heavenly bodies.

ATLANTIS. A fabulous island of the Atlantic.

ATOMIC. Relating to atoms.

AUGITE. A simple mineral, of a dark green colour, which enters into the composition of several varieties of volcanic rocks.

AURELIA. A chrysalis.

B.

BASALT. A common variety of trap-rock, composed of augite and felspar, often found in regular pillars of three or more sides, called basaltic columns. It is of a dark green colour, and very hard and compact.

BITUMEN. Mineral pitch.

Bituminous Shale. Shale impregnated with bitumen.

Blende. A metallic ore, composed of zinc and sulphur.

Bot. A species of insect.

Botryoidal. Resembling a bunch of grapes.

Boulders. Large round blocks of stone.

Burrowing Shells. Lithodomi.

Breccia. A rock composed of angular fragments, cemented by a mineral substance.

C.

Calamites. Vegetable fossils of coal-measures.

Calcareous Rock. Limestone.

Calcareous Spar. Crystallized carbonate of lime.

Calcaire-Grossier. A series of strata found in the Paris basin.

Calcedony. An uncrystallized silicious simple mineral.

Calx. Any substance reducible to powder by burning.

Cannel. A species of coal.

Carbon. A simple elementary body, found pure in the diamond, and nearly so in charcoal and anthracite.

Carbonic-acid Gas. An inflammable gas, composed of carbon and oxygen. It supports neither life nor flame.

Carbonates. All combinations of carbonic acid with other substances. Limestones are carbonates of lime.

Carboniferous. A technical name of an ancient group of secondary strata. Beds containing coal, are called carboniferous.

Caylamite. A precious stone.

Centrifugal. Receding from the centre.

Cetacea. Animals of the whale tribe.

Cephalaspis Lyelli. An extinct animal, named after Sir C. Lyell.

Chevittes. A kind of marine animal.

Chloride. A compound of chlorine with a combustible body.

Chlorine. A gaseous body; a bleaching liquid.

Chlorate. Chloric acid with a base.

Choke-damp. Miners' term for carbonic acid.

Clay-slate. A species of slate.

Cinnabar. Sulphuret of mercury.

Coal-field. The district in which coal exists.

Coal-measure. The strata that alternate with coal in the mine.

Coniferæ. Plants which bear cones, in which the seeds are contained, as, fir, pine, &c.

Conglomerate. Fragments of rocks, or gravel, cemented together by a mineral substance.

Coral. The shells of a genus of marine animals, or polypi.

Cornelian. A precious stone.

Corundune. A species of crystal.

Cosmogony. The rise or birth of the world; the creation.

Cretaceous. Belonging to chalk.

Crystals. Simple minerals found in regular forms, and frequently transparent.

Crystalline. Containing crystals, or exhibiting the texture or appearance of crystals.

Cryptogamic. Plants whose organs of reproduction are concealed, as, ferns, mosses, sea-weeds, fungi.

Culm. A kind of small coal.

Culex, (gnat). A genus of insects.

Cycadeæ. An order of tropical plants, whose foliage spreads in a circle.

D.

Debris. Fragments of rock, ruins, rubbish, &c.

Decompose. To separate the constituent parts of a compound body.

Degradation. Placing lower; the wearing down of strata.

Diluvium. Those accumulations produced by the deluge.

Denudation. The laying bare of inferior rocks by the action of running water.

Deposits. Strata lodged by water.

Dermestes. A genus of insects.

Dicotyledonous. A family of plants with two *cotyledons*, or seed-lobes.

Dillage Rock. Greenstone.

Dip. When a stratum inclines to the horizon, the angle of inclination is called the *dip*.

Disintegrate. To separate into particles.

Dolerite. Trap-rocks composed of augite and felspar.

Dolomite. A crystalline limestone. Named after Dolomieu, the French geologist.

E.

Earth's Crust. That part of the earth accessible to man's observation.

Echini. Shell-fish set with thorns.

Ecliptic. A great circle of the sphere, &c.

Edentates. Animals without teeth.

Emery. An iron ore.

Eocene Period. The earliest of the tertiary epochs.

Epicycles. Little circles whose centres are in the circumferences of greater circles.

Equisetum, *or* Cycas. Fossil-coal plants.

Erratic Blocks. Large detached stones.

F.

Felspar. A simple mineral, which constitutes a material of rocks. It contains potash or soda, and sometimes both these alkalis, in its composition.

Felspathic. Of or belonging to felspar.

Fern. A plant.

Ferruginous. Containing iron.

Fire-Damp. Carburetted hydrogen—common coal gas.

Fire-Mist. Star-dust.

Floetz Rocks. Rocks, most frequently occurring in horizontal beds.

Flora. The trees or plants of a country.

Fluviatile. Belonging to a river.

Formation. A group of rocks belonging to the same period, or which had the same origin.

Fossil. All minerals are fossils, but the term is now confined to the remains of plants and animals found in the earth.

Fossil-Bos. A genus of extinct quadruped, allied to the ox.

Fossil-Cervus. Fossil-deer.

Fossiliferous. Containing organic remains.

Fossil-Salt. Rock-salt.

Freestone. A species of common stone.

Fungi. A class of plants of the mushroom tribe.

G.

Galena. An ore composed of lead and sulphur.

Garnet. A crystal of a deep red colour, found in several igneous rocks.

Gault. Beds of clay and marl, which occur between the upper and lower greensand.

Gavias. The crocodile of the Ganges.

Genera. The plural of genus.

Genus. A class of beings comprehending many species.

Geology. A description of the structure of the earth.

Gneiss. A stratified primary rock of the granitic family, with a laminated texture.

Granite. A primary rock, composed of felspar, quartz, and mica.

Greensand. Beds of sand, sandstone, limestone, &c., which contain green earth.

Grauwacke. The lowest members of the secondary strata.

Greenstone. A trap-rock, composed of hornblende and felspar.

Grit. A coarse-grained sandstone.

Gypsum. A compound of lime and sulphuric acid, called also sulphate of lime. Plaster of Paris is obtained from this substance. It abounds in the vicinity of Paris.

H.

Hastings Sand. Strata named from the town of Hastings.

Herbiferous. Feeding on plants.

Helicinæ. The snail tribe.

Hippopotamus. The river-horse; an animal found in the Nile.

Hornblende. A dark green mineral, which forms a principal ingredient of trap-rocks.

Humus. A kind of vegetable mould.

Hyacinth. A plant; a precious stone.

Hydrochloric. A compound of hydrogen and chlorine.

Hydrogen. An inflammable gas, and one of the constituents of water.

Hypogene. A term proposed instead of primary.*

Hypothesis. A supposition; a system formed under some principle not proved.

I.—J.

Ichthyosaurus. An extinct gigantic reptile.

Incandescent. Becoming of a white heat.

Incipient. Commencing.

Incumbent. Resting upon.

Indurated. Made hard.

Infusoria. Animalcula found in infusions, or in stagnant water.

Igneous Rocks. Rocks which owe their origin to fire.

Iguanadon. An extinct animal of the lizard tribe.

Iguanadon Mantelli. An extinct monster, named after M. Mantelli.

Inorganic. Without organs.

Isothermal. Zones of the earth, which have an equal degree of mean annual heat.

Jasper. A hard stone of a bright, beautiful green colour.

K.

Kamseen. A hot suffocating wind which blows in Egypt.

Killas. A local name for strata that rest on granite, in Cornwall.

L.

Lacustrine. Belonging to a lake.

Lagoons. Small lakes.

Laminæ. The layers of a stratum.

Lammer-Geyer. The bearded eagle.

Landscape-Stones. Stones which exhibit appearances like painted landscapes.

Landslip. A portion of land which has slid down from its former position.

Lapidify. To convert into stone.

Larvæ. Insects in the caterpillar state.

Lava. The melted stone which issues from volcanoes.

Lepidodendrum. An extinct plant, which formed a link between flowering and flowerless plants.

Lias. A local name for a species of limestone.

Lichen. A species of nutritious moss.

Lignite. A species of coal.

Limacenæ. A family of snails.

Lithodomi. Molluscous animals, which form holes in solid rocks.

Lithographic Stone. A slaty

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* Some granites being more recent than many of the secondary or tertiary formations, some geologists deem it a manifest contradiction to apply the term primary to such rocks; and, hence, they substitute hypogene.

compact limestone, used by lithographers.

Lithological. Stony structure, or character of strata.

Loam. A mixture of sand and clay.

Lodes. Principal veins in mines.

Lusus Naturæ. Sports of Nature.

Lycopodiaceæ. Club-mosses.

M.

Madrepore. A term applied to those corals distinguished by superficial star-shaped cavities.

Magnesian Limestone. Limestone which contains much of the earth; magnesia.

Mammalia. That class of animals which give suck to their young.

Mammillary. A surface studded with rounded projections.

Mammoth. An extinct species of elephant.

Marl. A mixture of clay and lime.

Mastodon. An extinct quadruped allied to the elephant.

Marsupalia. That class of quadrupeds which carry their young in a sack or pouch under the belly; the kangaroo, for example.

Medusa. Marine radiated animals, without shells.

Megalonyx. A gigantic extinct animal.

Megatherium. An extinct gigantic animal, resembling a sloth.

Megalosaurus. An extinct gigantic amphibious animal, of the saurian or crocodile tribe.

Megalosaurus Bucklandi. An extinct monster, named after Dr. Buckland.

Menstruums. Liquids used in infusions.

Metalstone. A stratum common in coal-measures.

Metalloid. The metallic base of an alkali.

Metalliferous. Producing metals.

Metamorphic Rocks. Rocks supposed to have been produced from the worn-down materials of primary rocks.

Meteoric. Resembling a meteor.

Mica. A mineral of a shining silvery appearance, capable of being separated into very thin leaves. The shining scales in granite are mica.

Mica-Slate, Mica-Schist, Micaceous Schistus. This class of rocks contains a large portion of mica, mixed with quartz. It belongs to the hypogene or primary series.

Mineral Veins. Fissures in rocks, filled with substances different from the rock.

Miocene Period. That which next succeeds the Eocene.

Monad. A term applied by Buffon and his followers to animalcula which they supposed to constitute the elementary molecules of organic beings.

Monitor. An animal of the lizard tribe, some species of which are found in a fossil state.

Monocotyledons. Plants with only one cotyledon, or seed-lobe. Palms, grasses, &c., belong to this class.

Muriate of Lime. Muriatic acid and lime.

Muriate of Soda. Common culinary salt. It is composed of muriatic acid and soda.

Myriad. Ten thousand.

Muschelkalk. A German name for a peculiar species of limestone.

N.

Naphtha. An inflammable fluid mineral substance, which issues from springs in many countries.

Nebulous. Misty; cloudy.

Neptunian Rocks. Aqueous rocks.

New Red Sandstone. Strata of a greenish grey, but generally of a red colour, sometimes called variegated sandstone.

Nitre. Saltpetre.

Nitrogen. A gas which combines

with oxygen, to form atmospheric air.

Nitrolin. A vegetable substance (humus), consisting of the same elements as animal flesh.

Noachian Deluge. The universal deluge.

Nucleus. A central mass, round which other matter is gathered.

Nigolosaurus. An extinct fossil-monster.

O.

Obsidian. A species of lava, resembling common green bottle-glass.

Œstri. A species of insect.

Olivine. An olive-coloured simple mineral, occurring sometimes in the form of grains and crystals, in basalt and lava.

Onyx. A semipellucid gem, of which there are many varieties.

Oolite, Oolitic. Limestone composed of rounded particles like the roe of fish.

Opalized Wood. Petrified wood, whose structure resembles that of the simple mineral opal.

Organic Remains. The fossils of plants and animals.

Ornithocephalus. An extinct animal, of doubtful nature.

Osseous Breccia. Fragments of bones found cemented in caves.

Oviparous. Bringing forth eggs.

Oxide. Metal combined with oxygen; rust in the oxide of iron.

Oxygen. A gas which supports life and flame. Atmospheric air contains about 21 parts of oxygen, and 79 of nitrogen.

Oxygenation. Combining with oxygen.

P.

Pabulum. Food; support.

Pachydermata. The thick-skinned order of quadrupeds. The horse and elephant are examples.

Palæotherium. An extinct gigantic quadruped, of the order Pachydermata, allied to the tapir.

Peat. A species of turf.

Petrifactions. Bodies formed by the conversion of wood into stone.

Petroleum. A liquid mineral pitch.

Phanerogamic Plants. Plants in which the organs of reproduction are apparent.

Phase. A change in the appearance of a body; as the phases of the moon.

Phenomenon. An unusual appearance in nature.

Pitch-stone. A volcanic rock which appears like indurated pitch.

Phosphate. A kind of mineral; also a salt.

Phosphuretted Hydrogen. Hydrogen and phosphorus united.

Physics. The sciences which treat of the properties of bodies, laws of motion, &c., &c,

Plastic Clay. A clay used for making pottery.

Plesiosaurus. An extinct amphibious animal of the saurian or lizard tribe.

Pliocene Period. A more recent epoch than the Miocene; it is divided into the Older Pliocene and the Newer Pliocene.

Pliocene (Newer). That which immediately preceded the recent era.

Plumbago. Black lead.

Plutonic Rocks. Igneous rocks, supposed to have been formed at great depths in the earth.

Polypi. A sort of marine insects, with many feet.

Portland Beds. A series of limestone strata, of the oolite group, found in the Isle of Portland, off Dorsetshire.

Porphyry. An igneous, unstratified rock.

Potash. An impure, fixed alkaline salt.

Pous-de-Mer. A sort of fish.

Primary. First; original.

Proteaceæ. A family of plants.

Protigine. A plutonic rock.

Pterodactylus. An extinct monster.

Pudding-Stones. Conglomerates.

Pulex. A class of insects.

Pumice. A light spongy lava; obsidian in a frothy state.

Purbeck-Beds. Limestone strata, of the wealden group.

Puzzolana. Volcanic ashes, of the nature of Roman cement, much used in Italy for building.

Pyrites of Iron. A compound of sulphur and iron.

Pyrometer. An instrument for measuring high degrees of heat.

Pyrogeneous. Produced by fire.

Q.

Quadrumana. The order of mammifers, to which apes belong.

Quartz. A simple mineral, composed of pure silica.

Quartoze. Of or belonging to quartz.

R.

Radiation. Emission from a centre every way.

Recent. *Recent*, in geological language, means the historic era; or, since the creation of man.

Red Snow. Snow sometimes seen in the N. of Europe, turned red by the immense number of animalcula contained in it.

Relative Motion. Apparent motion, though it may not be actual motion.

Reticulate. To cover with lines, like net-work.

Rock. In geology, a mass of strata, whether stony, or otherwise.-

Rock-Salt. Salt found in mines.

Rock-Dyke. Rock-dykes resemble rock-veins, but are generally larger. *Dyke* is a local name in England and Wales for *wall.*

Rock-Cork. A species of asbestos.

Rock-Crystal. A name applied to the crystals of quartz.

Roe-Stone. A variety of sandstone.

Ruby. A precious stone of a red colour, next in hardness and value to the diamond.

Ruminantia. That class of animals which chew the cud.

S.

Sal-Ammoniac. A white solid, obtained by the condensation of equal portions of ammoniacal and muriatic acid gas.

Salt. Muriate of soda.

Sandstone. Sand agglutinated.

Sapphire. A precious stone, of a blue colour.

Savannahs. Open meadows, without wood.

Schorl. A species of crystal.

Scoriæ. Volcanic ashes or cinders.

Secondary Strata. An extensive series of stratified rocks, lying between the primary and tertiary formations.

Sedimentary Rocks. Rocks formed by deposits from water.

Selenite. Crystallized gypsum.

Silex. The Latin for flint.

Shale. Indurated slaty clay.

Shingle. The water-worn gravel on the sea-shore.

Shiver. A carbonate of lime.

Sienite. A kind of granite found at Syene, in Egypt.

Sigillaria. A fossil-coal plant.

Silica. One of the pure earths.

Silicious. Of or belonging to silica.

Silpha. A genus of insects.

Simoon. A hot suffocating wind in Arabia.

Sloth. An animal peculiar to America.

Soda. A fixed alkali.

Sodium. A metal obtained from soda.

Solipedes. Hoofed animals, as, the horse, camel, &c.

Solution. That which contains anything dissolved.

Species. A sort; a subdivision of a genus.

Spinel. A kind of precious stone.

Spheroid. A solid, approaching the form of a globe.

Star-Dust. Clusters of stars, so remote as to be undistinguishable by the best telescopes.

Stigmarial. A fossil-plant.

Strike *or* **Dip.** The direction or line of bearing of strata.

Strata. A series of successive layers of earth, gravel, &c.

Stratification. An arrangement of rocks in strata.

Sub-Kingdoms. Subdivisions of the kingdoms of nature.

Sublimation. A chemical operation, which raises solid bodies in a gaseous form by the force of fire.

Submerge. To put under water.

Sulphureous Acid. A gas twice as heavy as atmospheric air, has a suffocating smell, and is fatal to animal life.

Sulphuretted Hydrogen. Hydrogen combined with sulphur.

Superposition. A more elevated position.

Swamps. Bogs, fens.

T.

Tabanus. A genus of parasitic insects.

Talc. A kind of fossil-stone.

Tapir. An animal.

Tertiary Strata. A series of sedimentary rocks, incumbent on the secondary strata.

Testacea. Molluscous animals, with a shelly covering.

Theory. Speculations; a plan or system yet subsisting only in the mind.

Thermal. Hot.

Toad-Stone. A kind of mineral.

Toad-Stool. A plant, of the mushroom tribe.

Topaz. A yellow gem.

Tourmaline. A simple mineral.

Trap-Rocks. Igneous rocks, composed of felspar, augite, and hornblende. Basalt, amygdaloid, dolomite, greenstone, are varieties of this rock.

Trap-Dykes. Large veins in traprocks.

Trachyte. A variety of lava.

Transition-Rocks. Strata supposed to have been formed when the earth was passing into a habitable state.

Travertine. A rock deposited from the water of springs, holding lime in solution.

Tufa (Calcareous). A deposit from calcareous waters. This rock is more porous than travertine, though similarly produced.

Tufa (Volcanic). A variety of volcanic rocks.

V.

Vitrify. To change into glass.

Vertebrated Animals. That class of animals which are furnished with a back-bone.

Viscera. The bowels.

Vitriol. A sulphuric acid, with an earthy or metallic base.

Volatile. Having the power to pass off by spontaneous evaporation.

Volcanic. Of or belonging to volcanoes.

W.

Wacke. A variety of basalt.

Weald. A wood or grove.

Wealden Beds. A peculiar sort of strata.

Z.

Zamiæ. A species of pine-nuts.

Zircon. The hyacinth.

Zoophytes. The lowest class of animals, which form, as it were, the link between the animal and the vegetable kingdoms.

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